NESTING AND BROOD REARING ECOLOGY OF THE GREATER PRAIRIE CHICKEN IN THE SHEYENNE NATIONAL GRASSLANDS, NORTH DAKOTA

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PHASE I

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Cooperative Study between:

Rocky Mountain Forest and Range Experiment Station

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Rapid City, South Dakota

and

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INTRODUCTION

The greater prairie chicken (_Tympanuchus cupido_) has declined in numbers in recent years. Westemeir (1980) reports that populations have declined in 11 of 12 states and completely disappeared in 6. Conversion of prairie to cropland, overgrazing, annual burning, annual haying, and other agricultural activities continue to be the main cause of population declines. Although these activities are credited with recent declines in prairie chickens populations, less intensive agriculture is believed to have historically increased local populations and extended their range northward (Hamerstrom et. al. 1957).

Schwartz (1945), Baker (1953), and Hamerstrom et al. (1957) estimated that 30, 60, and 30% of occupied habitat in Kansas, Missouri, and Wisconsin respectively had to be maintained in permanent grassland if a viable prairie chicken population was to exist. Hamerstrom et al. (1957) further stated that birds were abundant only in areas with at least 35% grassland. Quality of the permanent grassland is also very important. Christisen and Krohn (1980) comparing three areas in Missouri, found that the region with the greatest amount of permanent grassland had a lower density of prairie chickens than expected, which they attributed to the poor quality of grassland available. Lack of quality grassland most often affects

the availability of nesting and brood rearing habitat, considered to be the most important factor influencing prairie chicken population levels (Hamerstrom et al. 1957, Kirsch 1974, Westemeir 1980). Although spring and summer ecology of hens and broods is important, it is probably the least understood period in the life cycle of the prairie chicken (Hamerstrom and Hamerstrom 1973). Radio telemetry studies have yielded some information on habitat use during nesting and brood rearing (Silvey 1968, Bowman and Robel 1977, Svedarsky 1979), but more information is needed.

A study including both sharp-tailed grouse (Tympanuchus phasianellus) and prairie chickens was conducted from 1975-1980 on the Sheyenne National Grasslands (Manske and Barker 1981). This study was initiated in the spring of 1983 with the following objectives:

(1) to determine the nesting and brood rearing habitat requirements of the greater prairie chicken

(2) to evaluate grazing management practices and their effects on prairie chicken habitat

(3) to develop management recommendations that may be compatable to both prairie chickens and livestock.

Field work was conducted from March through August in 1983 and 1984. In 1985 John Toepfer collected data on

nesting hens following a winter field season. Parts of these data are incorporated in this report.

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STUDY AREA

The north unit of the Sheyenne National Grasslands (SNG) is located approximately 50 miles southwest of Fargo North Dakota (ND) and encompasses approximately 27,150 hectares (ha) of federal land interspersed with 25,338 ha of private land (Fig. 1). Federal land is administered by the United States Forest Service (USFS) in cooperation with the Sheyenne Valley Grazing Association (SVGA). The primary economic use of the SNG is cattle grazing. There are 56 grazing allotments with 59 grazing systems utilized on public land. Allotments contain from one to five pastures, each with slightly different management schemes. Within an allotment cattle are usually grazed on a one-pasture continuous, a two-pasture rotational, a seasonal deferred rotation, or short duration basis. Because of the wide variety in number of pastures, dates of use and differences in stocking rates, the grazing systems are difficult to categorize. Table 1 presents the grazing systems utilized based on the number of pastures within an allotment. Grazing usually began 15-20 May and lasted for 5.5 to 6 months, ending 15-20 November. Other common management practices included mowing and burning of rank vegetation to stimulate new growth. Mowing was the most common practice and occurred in late July and early August. Very little area was burned during this study, although early spring has been designated by the USFS as

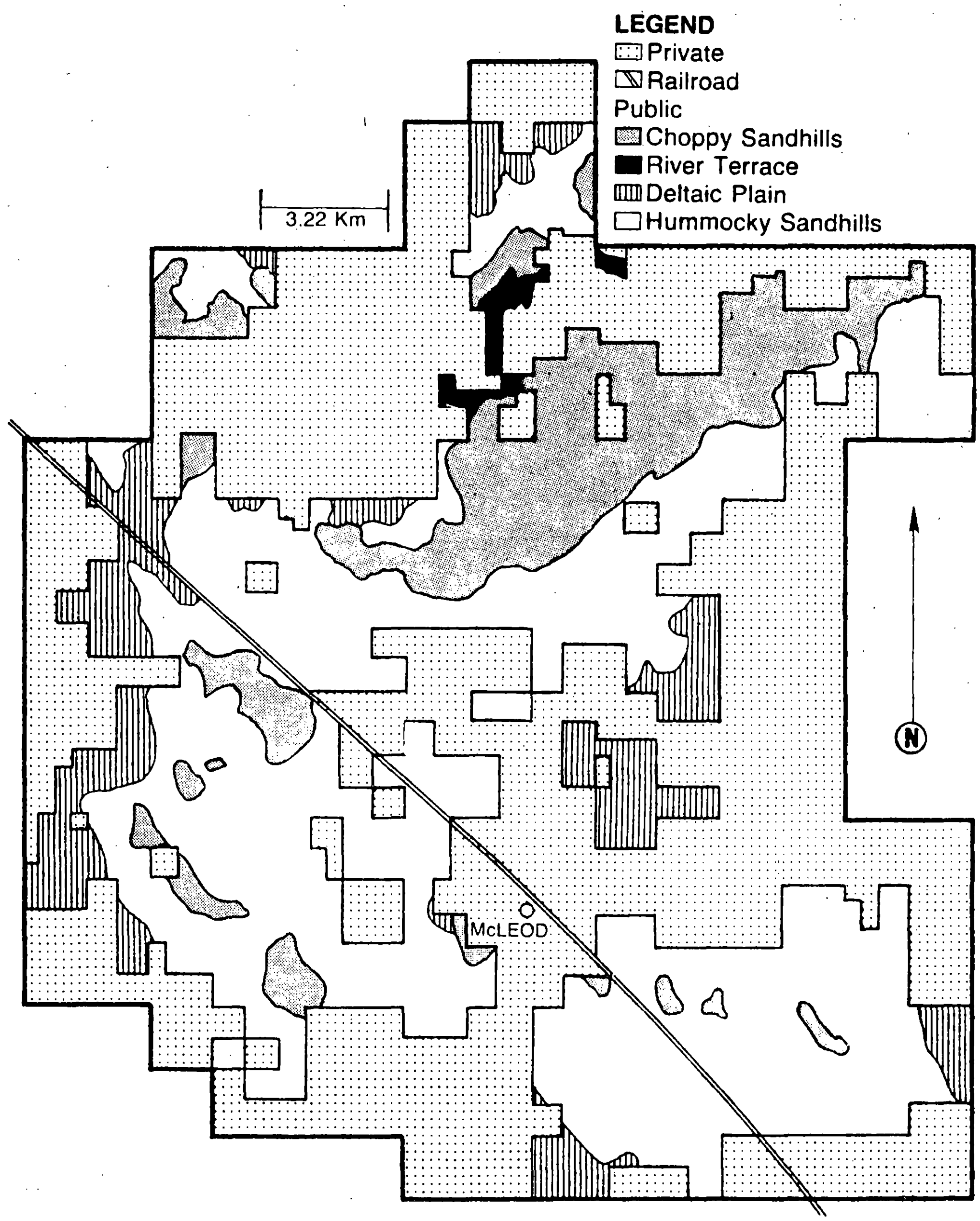

Fig. 1. The north unit of Sheyenne National Grasslands (cover type units adapted from Manske 1981).

the time to burn. The privately owned land was used for grazing, raising alfalfa, prairie hay, or corn silage for livestock or raising cash crops such as corn, sunflowers, soybeans, and small grains. In addition, some private land was incorporated into grazing allotments on public land (Table 1).

Table 1. Grazing systems on the SNG based on the number of pastures within an allotment, 1983-1984.

Grazing System *	Number of Pastures	Hectares Public	Hectares Private	Hectares Total
1-pasture	13	2083	65	2148
2-pasture	13	4104	0	4104
3-pasture	26	15136	470	15606
4-pasture	5	4893	0	4893
Short duration	2	917	0	917
No grazing	1	17	0	17
Total	60	27150	535	27685

*Some grazing allotments have 5 pastures but are treated as a 3-pasture and 2-pasture system within those 5 pastures.

The entire area is located on a geologic formation known as the Sheyenne Delta, formed during the end of the Wisconsin Glaciation (Seiler 1973). Deposition of sands, clays, and gravels occurred when the glacial meltwater of the Sheyenne River emptied into glacial Lake Agassiz. Below the delta is a nearly impervious layer of lake sediments creating a high water table.

The SNG is subject to a continental climate with cold winters and hot summers. In McLeod (Fig. 1) the average annual temperature is 5.5 Celsius (C). The coldest month of the year is January and the warmest months are July and August with mean temperatures of -13.5 C, 21.6 C, and 21.1 C respectively. Mean annual precipitation is 49.8 centimeters (cm) with 79% of this falling between the months of April and September. The frost free period averages 130 days beginning in mid-May.

The vegetation on the SNG consists of native woodland and grassland interspersed with croplands and associated introduced species. Manske (1980) described four habitat associations on the SNG (Fig. 1), of which prairie grouse primarily utilized two, the hummocky sandhill and deltaic plain. The hummocky sandhills association comprises the largest portion of the SNG and consists of gently rolling hummocks with relief of 1.5 to 3 meters (m). Soils of this association are primarily well drained loamy fine sands. Three fairly distinct plant communities have developed on each hummock. The upland community exists on the shoulder slopes of the hummocks. Dominant species of the upland are blue grama (Bouteloua gracilis), Kentucky bluegrass (Poa pratensis), sunsedge (Carex heliophila), needle and thread (Stipa comata), and prairie sandreed (Calamovilfa longifolia). The midland habitat exists on the back slopes and extends into the foot of the hummock.

Dominant species are big bluestem (<u>Andropogon gerardi</u>), little bluestem (<u>Andropogon scoparius</u>), Kentucky bluegrass, and switchgrass (<u>Panicum virgatum</u>). At the foot of each hummock and extending to the foot of the next hummock is the lowland community. Dominant species are <u>Carex lanuginosa</u>, Kentucky bluegrass, northern reedgrass (<u>Calamagrstis inexpansa</u>), Baltic rush (<u>Juncus balticus</u>), and switchgrass. In addition to the three native communities described above by Manske (1980) an upland shrub community was recognized in the current study. The upland shrub community usually occurs on the shoulders of hummocks and can extend to the foot. This community is most often dominated by snowberry (<u>Symphoricarpos occidentalis</u>) with an understory of associated upland or midland grasses and forbs.

Manske (1980) described the deltaic plain habitat association as the second largest association on the SNG. This association has little or no relief. Soils are loamy and have a higher moisture availibility than soils in the hummocky sandhill association. Two plant communities were described, the midland with dominant species Kentucky bluegrass, big bluestem, little bluestem, and Indiangrass (<u>Sorghastrum nutans</u>) and the lowland with dominant species slender spikerush (<u>Eleocharis compressa</u>), <u>Carex lanuginosa</u>, northern reedgrass, and Kentucky bluegrass. The uplands in this association, which have dominant

species similar to those in the hummocky sandhill association, are limited in number. One additional less common lowland native community was identified during this study, the lowland II community dominated by prairie cordgrass (*Spartina pectinata*), northern reedgrass, Kentucky bluegrass, and *Carex* spp.

Both the deltaic and hummocky sandhill associations have small areas of planted shelterbelts, tree claims, groves of aspens (*Populus tremuloides*) and cottonwoods (*Populus deltoides*) and small wetlands dominated by a wide variety of species. Major farming activities in the hummocky sandhills includes corn for silage, alfalfa, prairie hay and grazing. The deltaic plain is more intensively farmed and cash crops such as corn, soybeans, small grains, and sunflowers are grown. In addition, alfalfa, prairie hay and silage are produced for winter livestock foods on the deltaic plain habitat association. Prairie hay fields in hummocky sandhills usually remain in native vegetation while many fields in the deltaic plain have been planted to more productive species such as reed canary grass (*Phalaris arundinacea*), redtop (*Agrostis alba*), smooth brome (*Bromus inermis*) and Kentucky bluegrass.

METHODS

Censusing

Booming and dancing grounds were censused in April by USFS and study personnel. Display grounds (arenas) censused by USFS personnel were counted one to three times during a one-week period. Research personnel censused arenas in the vicinity of trapping activities a minimum of three times during the month of April. All males on grounds were identified as prairie chickens, sharptails, or prairie chicken x sharptail hybrids.

Trapping, banding and radio tagging

Four booming grounds were selected for trapping based on accessibility, distance from field station, and number of displaying cocks. In addition, a trapping technique was tested on one sharptail dancing ground early in 1983. Trapping was conducted throughout the month of April, rotating efforts between booming grounds in order to minimize disturbances.

Most grouse, were captured on arenas during the morning display period. Three types of traps were employed: 1) paired rocket nets placed over the dominant cock, used only in 1983; 2) bownets (Anderson and Hamerstrom 1967); and 3) walk-in traps, an experimental modification of a clover leaf trap. To replace a faulty transmitter, one hen was recaptured on a nest with a long handled net.

Grouse were weighed using a single counter balance scale or a Pesola spring scale. Age was determined by outer primary wear and scapular molt (Toepfer unpubl. data). Individuals were banded with a unique combination of three colored plastic and one aluminum butt-end bands. In addition, 46 prairie chicken hens, 2 sharptail hens, and 1 hybrid hen were fitted with radio transmitters mounted on a bib (Amstrup 1980). Grouse were released on or near the display ground of capture. During the 1985 nesting season additional information was gathered by John Toepfer on 14 radio-tagged prairie chicken hens and 2 sharptail hens.

Telemetry equipment

Three types of transmitters emitting a pulsed signal from 150 to 151 megahertz were employed. Thirty-five SM1 and four SB2 transmitters were purchased from AVM Instrument Company, California. The SM1 power sources were one 60 mah NiCad battery capable of supplying transmitter power for 36 days without recharging and one row of five solar panels. The SB2 power sources were two 20 mah NiCad batteries capable of supplying transmitter power for four days without recharging and two rows of five solar panels. Mean weights of the packages were 16.8 grams (g) (SM1) and 22.0 g(SB2). The SB2 transmitter was modified by removing approximately 15 cm from the 30 cm whip antenna. One sharptail hen was fitted with a battery

powered SM1 transmitter with a life expectancy of 270 days. The entire transmitter package, except for the solar panels, was covered by feathers.

A Telonics model TS-1 Scanner/Programmer plugged into a Model TR-2 series receiver (Telonics, Mesa, Arizona) was used to receive signals. Most relocations were made using a single eight-element 3.8 m antenna. A bearing dial and pointer attached to the antenna mast permitted directional readings. Bird locations were determined by triangulating from two or three recognizable points on 8 inch/mile Soil Conservation Service (SCS) air photos. Ground to ground range was between .8 and 1.6 kilometers (km). Toepfer (1976) estimated mean accuracy using similar equipment to be 41 m at distances from 305 to 537 m. A fixed-wing airplane with a two-element yagi mounted on each strut was used to relocate birds that could not be found from the ground. Hand held yagis were utilized to pinpoint hens on nests and to periodically flush hens.

Nests

Radio signals emanating from the same place several days in a row indicated death or incubation had begun. Incubating hens were approached and if on a nest flushed, and a general nest site description and clutch size recorded. At some nests in 1983 and all nests in 1984 photo-plots were taken at the nest within five days of the

start of incubation. Four 10-m transects were established in the cardinal directions. Two photo-plots were taken at the nest and one each at 5 and 10 m out from the nest. Photo-plots consisted of colored slides of a 1-m^2 piece of pegboard held vertically behind the vegetation (Toepfer unpubl. data). Photos were taken from a distance of 3 m at a height of 1 m. The nest was marked by placing a 30 cm orange topped stake 10 m from the nest so that approximately 15 cm was showing above the vegetation. Hens were periodically monitored through the incubation period to determine date of hatch or nest destruction.

Following nest destruction or hatching, further vegetation analysis was completed at the nest site. Four 10 m transects were established as before. Along these transects, canopy coverage by species was collected at 1-m intervals in .1-m^2 quadrats (Daubenmire 1959). Dominant residual vegetation in each quadrat was identified when possible and considered seperately from new growth. Robel pole (Robel et.al.1970) readings were taken from four directions at the nest and two directions at 1-m intervals away from the nest for 10 m. The readings represented the structure of the vegetation at the end of incubation which was quite different than when the nest site was selected. At each nest 76 readings were recorded, summed, a mean computed, and the means averaged. In addition, the four readings taken from the center of the nest bowl were

averaged and a mean of these means was calculated. Only nests from 1983 and 1984 are included and no Robel pole readings were taken from nests in alfalfa. All nest site locations were plotted on SCS air photos.

Photo-plot transects

Photo-plots were taken every two weeks along 21 permanent transects during the study. Two additional transects were established and photo-plots of upland transects were taken every four weeks in 1984. Thirty-meter photo-plot transects were established in 11 different pastures near booming grounds where trapping had been conducted. A transect established in 1984 on a burned site was not near any of the grounds trapped on. Colored slides were taken at 5-m intervals along the transect for a total of six photographs per transect. Most transects were established in 3-pasture deferred systems, the most common grazing system on the SNG (Table 2). Vegetation monitoring began before new growth provided cover and ended the last two weeks of August. Photo-plots for 1983 and 1984 were not taken on the same dates and they were combined as follows; early May (May 1) before greenup, mid-May (May 15) greenup begins, early June (June 1), mid-June (June 15), early July (July 1), mid-July (July 15), late July (July 30), mid-August (Aug 15), and late August (Aug 30).

Table 2. Photo-plot transect location in relation to pasture system and community type.

Pasture System	Upland	Community Type Midland	Lowland
1-pasture	0	0	1
3-pasture	6	5	9
Burn	0	1	0
Prairie hay	0	1	0

Analysis of all photo-plots at nests and transects involved selecting ten equally spaced columns of dots on each slide. Three readings were taken on each column: 1) height, the highest point at which vegetation intersected the column; 2) effective height, the point below which all other dots in that column were obscured by vegetation; 3) obstruction category, the dominant type of vegetation providing visual obstruction. Nine obstruction categories were recognized; graminoids, forbs, brush, grass/forb, grass/brush, grass/forb/brush, forb/brush, water, and miscellanious. Those obstruction categories with more than one classification, e.g. grass/forb, had approximately equal proportions of grasses and forbs providing visual obstruction. There were 60 height, effective height, and visual obstruction readings taken at each photo-plot transect and 100 readings at each nest site.

Movements

Following destruction or hatching of nests, hens were monitored through August. An attempt was made to locate hens at least once every other day although hens that moved great distances from site of capture and hens with faulty transmitters were located less often. Telemetry data gathered were grouped into three periods: 1) renesting period- time between initial nest loss and initiation of incubation of a renest 2) non-brooding period- time following nest destruction or brood loss with no further nesting attempts ; 3) brood rearing period- time following hatch of nest until brood was lost or field season ended. Distances from nest to nearest booming ground and initial nest to renest were determined.

Habitat

Areas around each booming ground on which birds were trapped were cover-typed in early May and late August of each year. Vegetation was classified into the following height classes: Class I, 0-8 cm; Class, II 9-25 cm; Class III, 26-50 cm Class IV, over 51 cm. Each location plotted was assigned to one of the above height categories and a specific habitat community. Community type was determined from SCS air photos, flushes, photo-plot transects, marking of night roosts and nest site analyses. In addition each relocation was assigned a land disturbance code based on past and present land use,

cattle presence and ownership. Renesting hens were not included in analysis of disturbance-type use due to their ties to a nest site. Thus when cattle were moved into a pasture, hens with nests in that pasture did not shift their activities to a new disturbance type.

RESULTS

Census

Limited information is available about prairie grouse populations on the SNG prior to 1975. Manske and Barker (1981) summarized information from 1961-1974. Beginning in 1975 more intensive census efforts resulted in improved population estimates. Data from 1975 through 1985 are presented in Fig. 2 and indicate a decline from a high of 412 cocks in 1980 to 262 in 1985.

From 1975-1980 Manske censused the grouse on the SNG. In 1981 only a partial census was completed and is excluded from data presented in Fig. 2. From 1982-1985 the USFS began conducting censuses on a regular basis and personnel from this study assisted from 1983-1985. After 1982, most grounds were counted once or twice and even though the highest of two counts was recorded, population estimates probably represent a minimum since new grounds were not searched for. This becomes especially apparent in 1985 when more time was spent searching for dancing grounds and the sharptail population estimate increased dramatically. Many of the display grounds had a mixture of sharptails and prairie chickens; in such cases the .op arena was classified as a booming or a dancing ground depending on the species with the greatest number of

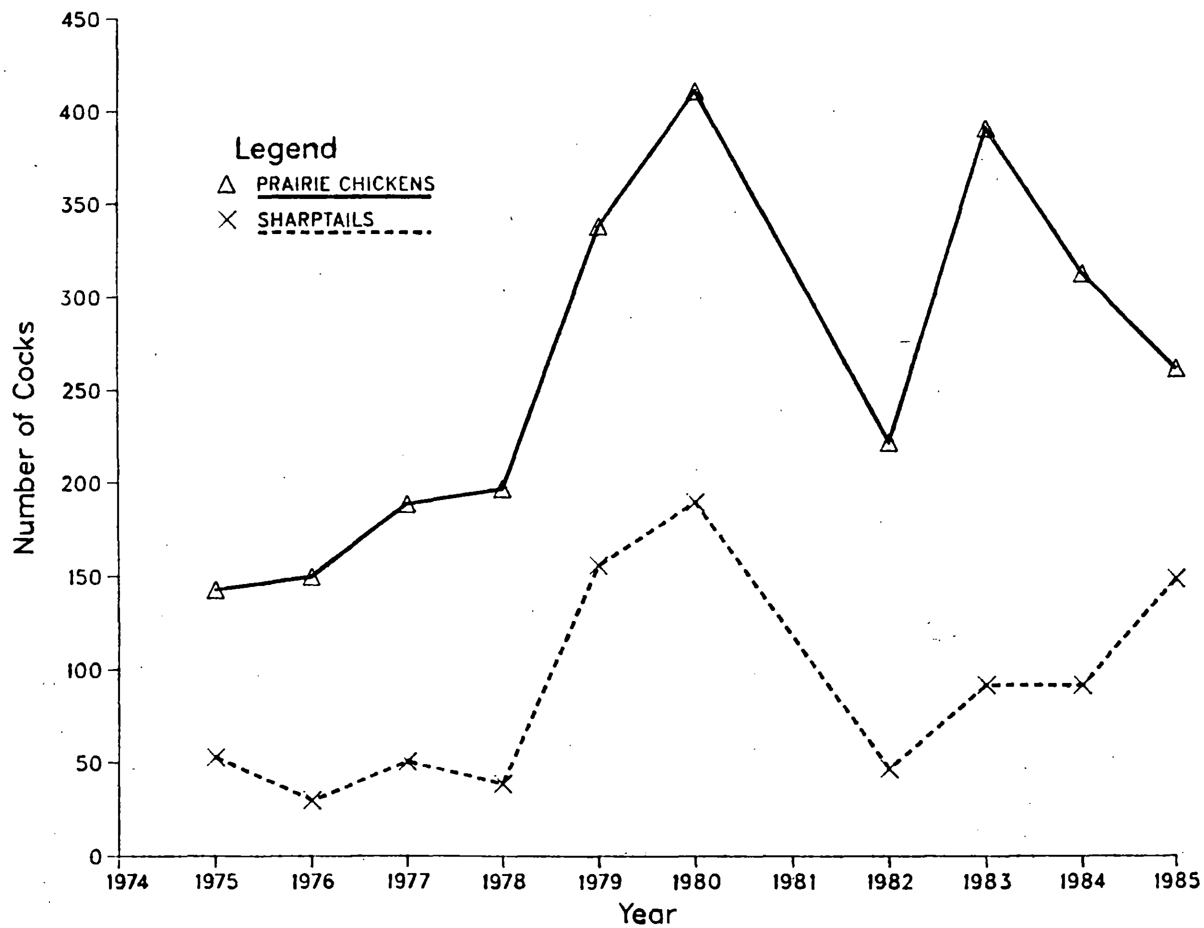

Fig. 2. Prairie grouse display ground counts on the Sheyenne National Grasslands, 1975-1985.

cocks. Numbers of cocks recorded on individual display grounds on the SNG from 1983-1985 are presented in Appendix 1.

Trapping

The four booming grounds selected for trapping were 02, 16, 24 and 25 (Fig. 3). Walk-in traps proved to be the most effective and caused the least disturbance. Of 111 grouse handled 10 were captured in rocket nets, 12 in bownets and 89 in walk-in traps. Trap mortality was minimal. One prairie chicken hen had a wing broken by a rocket net. A male hybrid and male prairie chicken died when a red-tailed hawk (Buteo jamaicensis) attacked them in a walk-in trap. One prairie chicken male died of shock shortly after removal from a walk-in trap.

The earliest a hen was captured was 2 April and the latest was 3 May. In 1983, 75% of the hens were captured between 20 and 25 April. In 1984, 61% of the hens were captured between 17 and 24 April.

Of 46 prairie chicken hens fitted with radio transmitters, 47.8% and 52.2% were aged as adults and juveniles respectively (Table 3). Two hens were classified as unknown age but egg laying behavior, weights and movements indicated that one was an adult and one a juvenile.

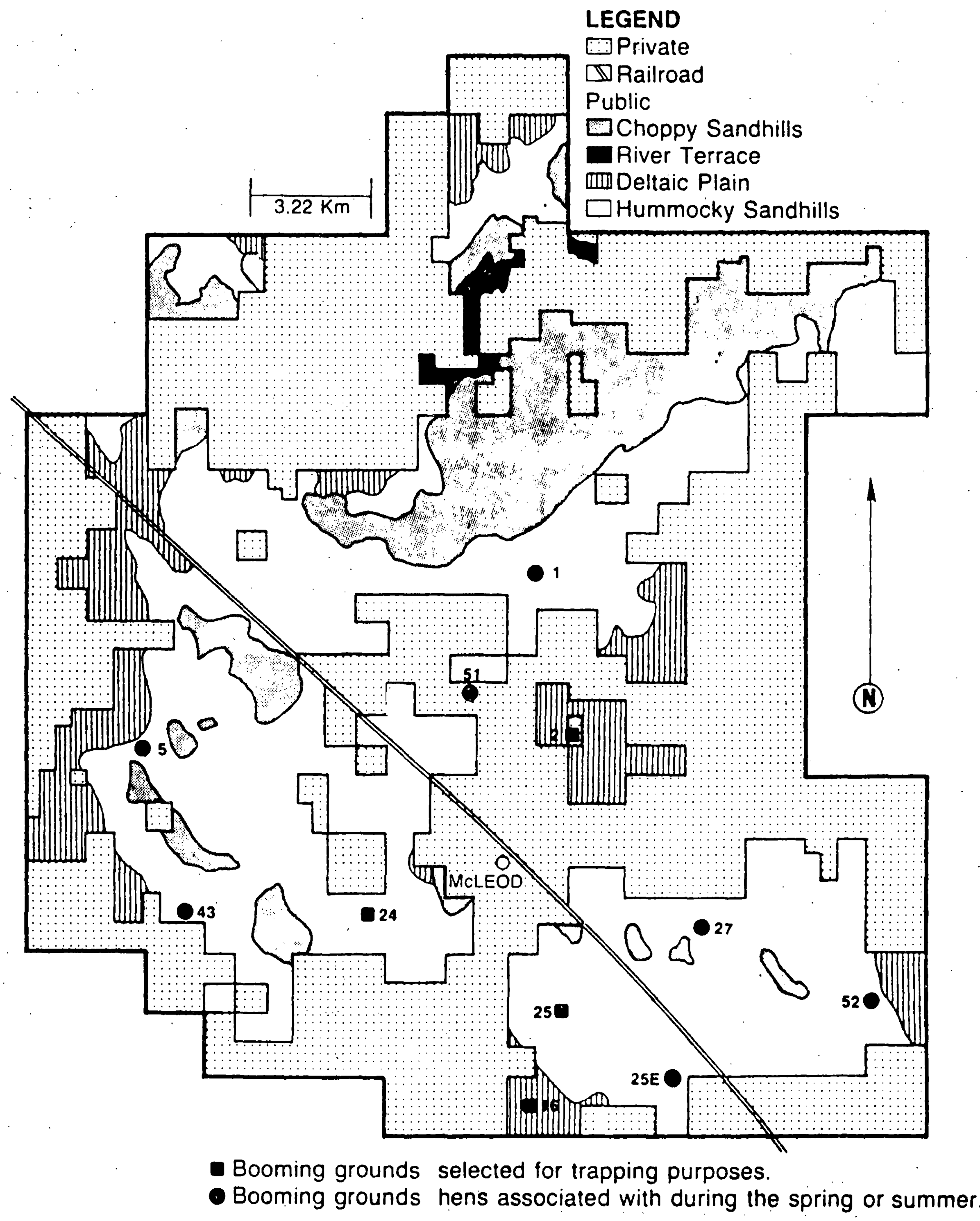

Fig. 3. Booming grounds selected for trapping and booming grounds some hens dispersed to in 1983 and 1984.

Only weights of known age birds captured in the spring were used to calculate mean weights. Mean weights of sharptails and hybrids were not calculated due to the small sample sizes (Table 4).

Table 3. Sex and age of prairie grouse captured on the SNG 1983-1984.

	Prairie chicken		Sharptail		Hybrid	
	Cock	Hen	Cock	Hen	Cock	Hen
Adult	30	21	1	1	1	0
Juvenile	15	23	1	1	0	1
Unknown	6	2	7	0	0	0
Total	51	46	9	2	1	1

Table 4. Mean weights of prairie chickens captured 1983-1984.

	Cocks			Hens		
	(N)	(Mean) g	(SD)	(N)	(Mean)	(SD)
Adult	25	1117.0	75.6	20	967.3	60.6
Juvenile	14	1084.2	70.9	22	937.4	50.0

An attempt was made to radio-tag at least 6 hens at each of the 4 booming grounds. Due to variability in hen attendance this was not always accomplished (Table 5)..pa

Table 5. Number of hens radio-tagged on each booming ground each year of the study 1983-1984.

Booming ground	Number 1983	Number 1984	Carry overs from 1983	Total
02	5	13	1	19[ab]
16	5	3	2	10
24	7	4	0	11
25	6	6	1	13[a]

[a]Includes one sharptail captured in 1984.
[b]Includes one hybrid captured in 1984.

Nesting

Over the course of three years, 43 initial nests, 17 second nests and 2 third nests of radio-tagged prairie chickens were located. Four initial nests and one renest of radio-tagged sharptails were observed. In addition, five nests of unmarked prairie chickens were located after they had hatched. Information gathered from nests of unmarked birds is not used in analysis unless specified. Data collected in 1985 are used where appropriate.

In eight instances, the suspected initial nest of a hen was not located, but the renest was found. A hen was recorded as having had an initial nest if an initial nest was found, a hen had been relocated several times in the same place indicating incubation, a hen exhibited a pronounced shift in daily patterns and/or a hen had a smaller clutch size and a later date of incubation initiation.

Initial nests

Chronology. Information gathered on 38 nests was sufficent to estimate the first day of egg laying. The date of nest initiation was calculated using an egg laying rate of one per day and back dating from an observed first day of incubation. Mean dates of first egg laid was 3 May 1983, 2 May 1984 and 22 April 1985. The earliest date an egg was laid in an initial nest was 17 April 1985 and the latest was 9 May 1983. The later dates of initiation of egg laying may represent loss of an initial nest early during egg laying. Assuming 3.8 days between copulation and first egg laid (Svedarsky 1979) the calculated copulation peak was 27-28 April in 1983 and 1984 and 18-19 April 1985. There appeared to be little difference in date of nest initiation between adults and juveniles with both initiating egglaying 2 May in 1983 and 1984 and 21 April and 25 April for juveniles and adults respectively in 1985.

Incubation length and nest attentivness. A hen was considered incubating if she was relocated and inactive in the same place two consecutive days or was relocated in the same place during the day and at night. Estimated incubation length ranged from 24-30 days with a mean of 26.6 days. (SD 1.5, n=14). Hens were very faithful to their nest sites as evidenced by the following events. Of 755 random incubation relocations, hens were found off

their nests only 15 times, eight of which were between the hours of 0600-0900, 5 between 1623 and 2016 and one at 1209 Central Standard Time (CST). One exception a juvenile, was off her nest for 3 hours and 6 minutes, seven days before her eggs hatched. There was evidence at two nest sites of hens returning after having been disturbed by a predator. In both instances large numbers of breast feathers were located around the nest but none of the eggs had been removed. All hens except one sharptail returned to their nests after being flushed by researchers. One juvenile hen incubated a clutch for 39 days before it was finally destroyed by a predator.

Clutch size and hatchability. Only clutch sizes for radio-tagged prairie chickens flushed shortly after incubation began were used in the following calculations. Average clutch size of 41 initial nests was 13.9 (SD 1.41). Mean clutch size of adults 14.3, (SD 1.28) was slightly larger than juveniles, 13.6, (SD 1.50, N=19). The smallest complete clutch (11) recorded for initial nests was laid by a juvenile while the largest (17) was observed twice, both adults.

Hatchability was determined from nests where no full or partial predation had occurred. Of 212 eggs in 15 initial nests 15% did not hatch including a full clutch of 13 eggs laid by a juvenile. Ten of 15 nests contained at least one egg that did not hatch. In addition four dead

chicks were found at three different nest sites. Two chicks had not successfully exited the shell and two apparently died of exposure during a two-day rain storm.

Nest success. A nest was considered successful if one egg hatched. Only nests of radio-tagged prairie chickens were used in calculations of nest success. There were eight hens whose initial nest was not located but radio-tracking suggested that it had been destroyed during egg laying or at the beginning of incubation. These hens were considered renesters. Four radios including that of the hybrid hen, subsequently failed before a nest was located and these hens were not included in the success calculations (Table 6). Nesting success is frequently calculated by dividing the number of successful nests located by the total number of nests found. Since most nests are located by flushing an incubating hen, this method fails to include those that are destroyed during egg laying and nests of hens killed during the egg laying periods (Table 7).

Table 6. Number of initial nests found, probable initial nests, successful nests and hens killed during egg laying for prairie chicken hens, 1983-1985.

	Initial nests found	Probable nests	No. successful	Dead Hens
Adult	23	8	9	3
Juvenile	20	0	12	6
Total	43	8	21	9

Table 7. Initial nest success calculated three ways; a) number of successful nests (SN) divided by total number of nests found (TNF), b) SN/TNF+ probable nests (PN) and c) SN/TNF+PN+ number of birds killed during initial egglaying (DB).

Age	Success SN/TNF %	Success SN/TNF+PN %	Success SN/TNF+PN+DB %
Adult	39.1	29.0	26.5
Juvenile	60.0	60.0	46.2
Total	48.8	41.2	35.0

In all calculations juveniles were more successful than adults (Table 7). Nest success was much higher in 1985 than in the previous two years and again juveniles were more successful than adults (Table 8).

Table 8. Nest success of adult and juvenile prairie chicken hens (SN/TNF).

	1983 %	1984 %	1985 %
Adult	30.0	28.6	50.0
Juvenile	55.6	50.0	100.0
Total	42.1	40.0	63.6

<u>Prenesting movements and distribution of initial nests</u>. Distances hens nested from booming grounds ranged from .1 to 2.4 km. Adult hens tended to nest somewhat closer to display grounds than juvenile hens. Eighty percent of the adult hens nested < 1.5 km from the nearest display ground while 70.6% of the juveniles nested < 1.5

km from the nearest display ground (Fig. 4,5, and 6). Juvenile hens nested an average of 1.2 km (SD=.65, N=17) from the nearest ground while adults averaged 1.1 km (SD=.55, N=15) away from the display ground.

Although little difference was recorded in the distance which juvenile and adult hens nested from display grounds there seemed to be a behaviorial difference between the two age classes during the pre-egglaying period. Adults and most juveniles nested nearest the booming ground on which they were captured. However, in 1983 and 1984, six juvenile prairie chickens and one hybrid moved an average of 9.7 km before nesting or being killed (Table 9). Only one adult in two years, moved 6.4 km after capture. That adult had been captured 30 April and may have been returning to the arena after losing an initial nest.

Table 9. Straight line distances from booming ground of capture to initial nest site or last location of dispersing juvenile prairie chickens, 1983-1984.

Hen I.D.	Distance (km) to nest site	Distance (km) to last location
1092	-	10.50
1363	4.81	-
1488	-	10.50
1610	15.30	-
1732	11.50	-
1126	-	11.50
1788*	-	4.02

*Hybrid

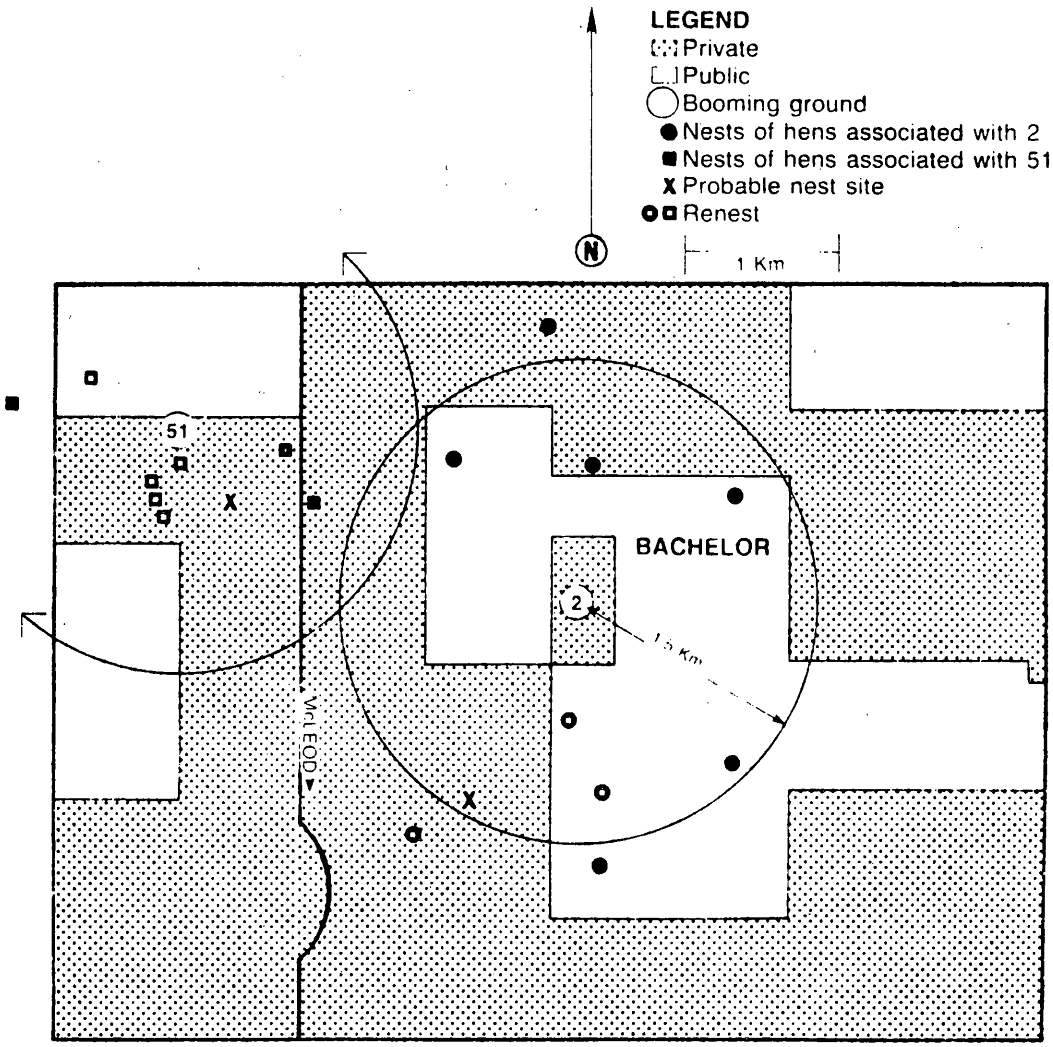

Fig. 4. Nest site locations near booming grounds 2 and 51, 1983-1985.

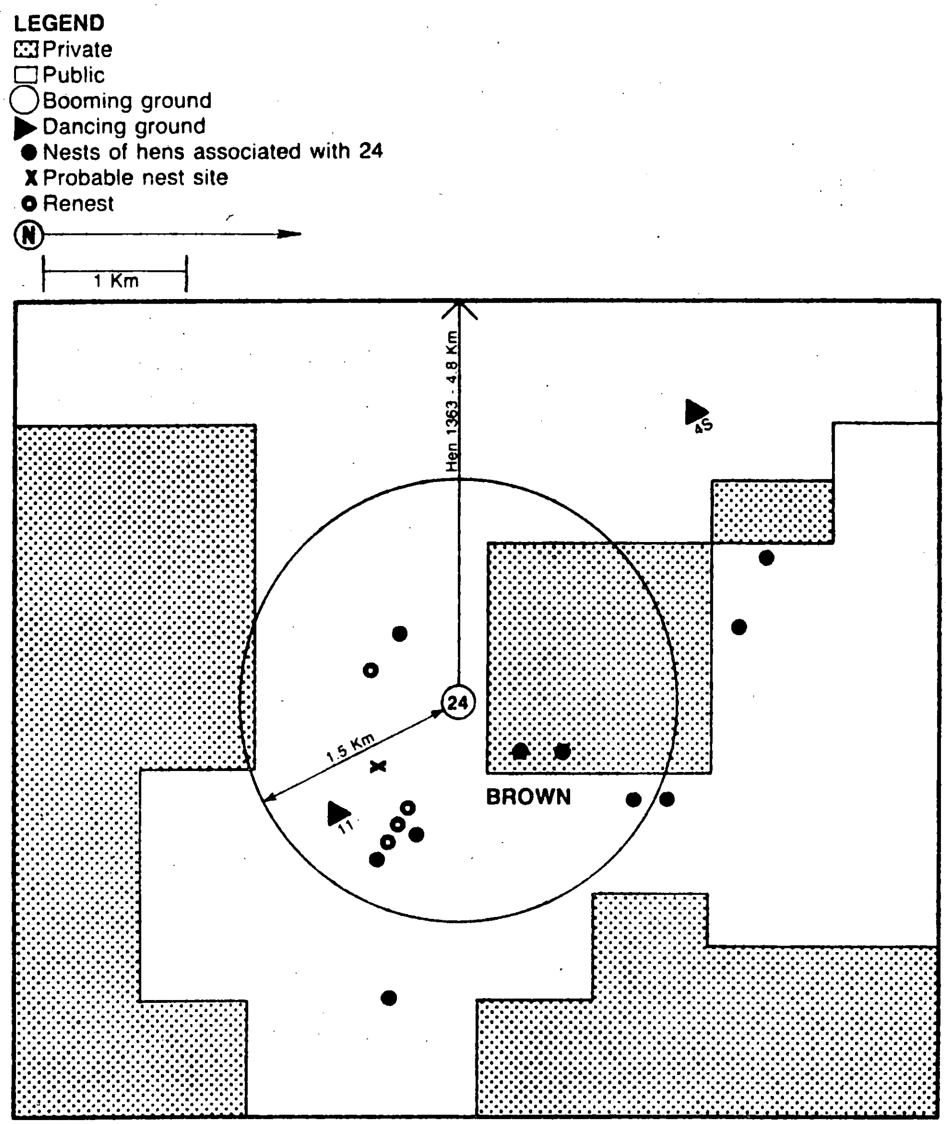

Fig. 5. Nest site locations near booming ground 24, 1983-1985.

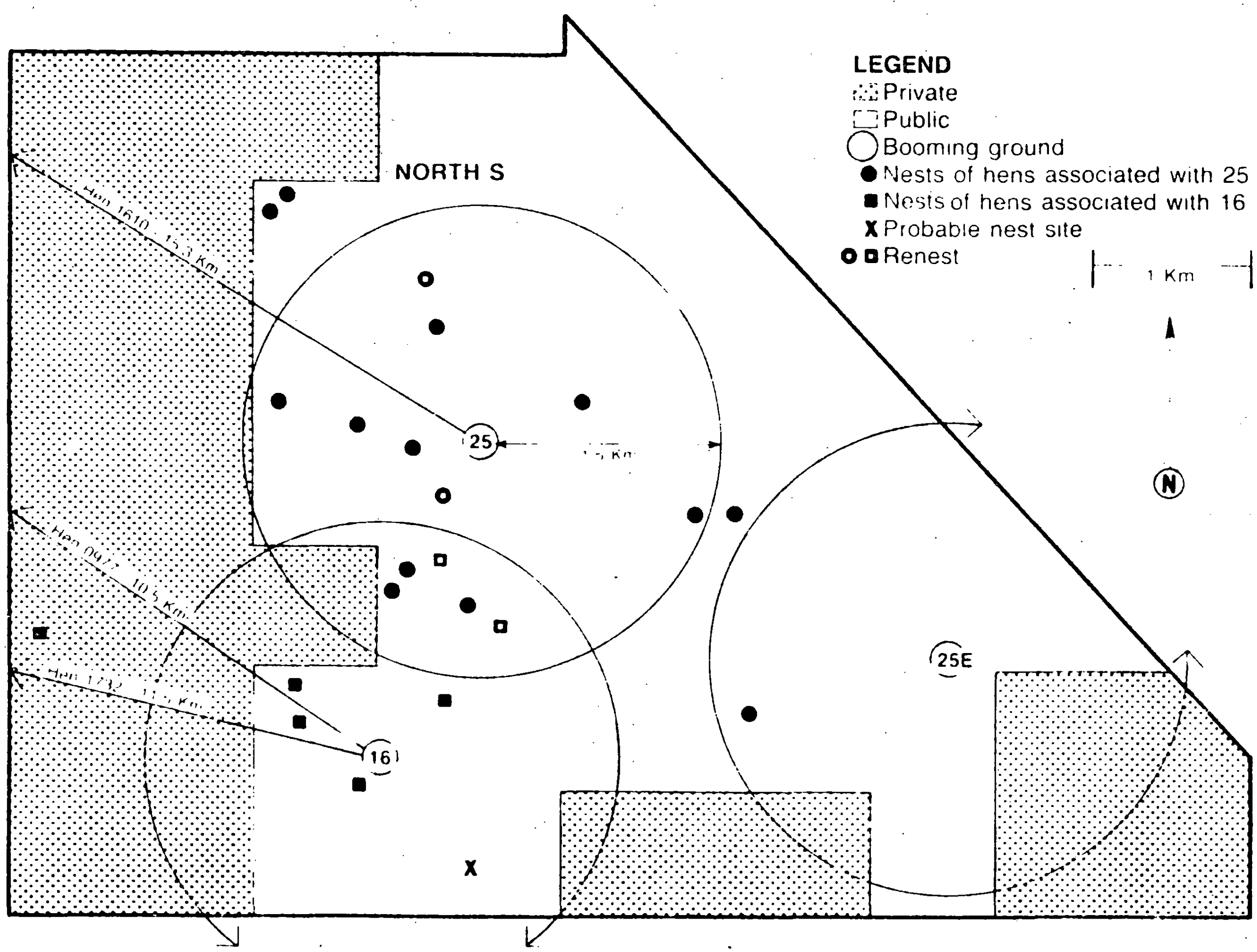

Fig. 6. Nest site locations near booming grounds 16 and 25, 1983-1985.

Sharptails initial nest. Initial nests of 4 radio-tagged sharptails were located over the course of three years. Two adults and two juveniles had a mean clutch size of 14 (SD=.82). Only one adult was successful. A juvenile abandoned her nest shortly after being flushed and was the only known study induced abandonment.

Renests

Timing of renests. The interval between destruction of initial nests and initiation of a renest was determined for eight hens. Renest initiation was calculated as with initial nests and the interval ranged from 1 to 16 days ($\bar{x}$=8, SD=4.4). One copulation was observed on 20 May, 3 days after the hen's initial nest was destroyed and she began laying 25 May.

Incubation length. Incubation periods determined for renests ranged from 24-29 days ($\bar{x}$=26.4, SD=1.6, N=8). The latest hatching date for a radio-tagged female was 19 July. One unmarked hen was killed by a mower while incubating on 25 July and represents the latest known date of incubation during the study.

Renesting capability. There were 24 hens that provided the opportunity for measuring renesting effort (Table 10). An adult hen was killed shortly after the loss of an initial nest and represents the only known mortality

in the renesting period. The data suggested that juveniles were less likely to renest than adults. Renesting effort could not be confirmed for 4 of 6 (66.7%) juveniles and 2 of 17 (11.8%) adults.

Table 10. Fate of hens after initial nests, 1983-1985.

	No.of Hens	Dead Hens	Successful Initial	Radio Failures	No Renest Found	Second Nests
Adult	36	6	9	3	3[b]	15
Juvenile	27	7	12	2	4	2
Total	63[a]	13	21	5	7	17[c]

[a] Counts carryover hens once for each year.
[b] Includes one hen that was killed between initial nest and renest.
[c] Two hens had second renests, not included.

Of the six hens that did not renest, two juvenles incubated their initial nest for 30 and 39 days. One juvenile and two adults localized shortly after the loss of their initial nests and may have initiated a renest that was not found. The other juvenile hen was very difficult to relocate and provided limited information.

Hens were capable of renesting after long periods of incubation. Two hens renested after incubating an initial nest for 21 days. Two hens renested twice.

<u>Clutch size and Fertility</u>. A total of 17 second nests and 2 third nests were located over the three-year period. Clutch sizes of adult renests ranged from 8 to 12

eggs and the mean of 11.4 (SD=1.85, N=17) was substantially smaller than initial nests. Two juveniles which renested had clutch sizes of 11 and 12.

Fertility of eggs in renests was higher than in initial nests. Only two of seven nests contained unhatched eggs and 92.8% of all eggs hatched.

Renest Success. Only nests of radio-tagged hens from 1983-1984 were used in calculations of renest success. One radio failed between initial nest and renest and that hen was excluded from calculations. Hens were much more successful with renests (Table 11) than with initial nests. Over the course of three years 34 Of 63 (54.8%) prairie chickens had a successful nest (Table 12).

Table 11. Renest success calculated three ways; a) SN/TNF b) SN/ (TNF+PN) c) SN/ (TNF+PN+DB).

	a) Successful %	b) Successful %	c) Successful %
Adult*	68.8	68.8	66.7
Juvenile	100.0	100.0	100.0
Total	72.2	72.2	68.4

*Fate of one renest unknown and excluded from calculation.

Table 12. Number of prairie chicken hens successful in bringing off a brood 1983-1985.

Age	Number hens	Radio failures No.	%	Unknown No.	%	Successful No.	%[b]	Unsuccessful No.	%[b]
Adult	36	3	8.3	1	2.7	20	62.5	12	37.5
Juvenile	27	2	7.4	0	0.0	14	56.0	11	44.0
Total[a]	63a	5	7.9	1	1.5	34	59.6	23	40.4

a. Includes carryover hens counted once each year.
b. Does not include radio failures or hen whose nest fate was unknown.

<u>Distances from initial nest and nearest display ground</u>. Absolute distances from initial nest could be calculated for only six hens ($\overline{x}$=1.3 km, SD=.81). The closest a renest was located to an initial nest was 0.4 km by an adult while the farthest was 2.5 km by a juvenile. This does not include a juvenile hen that may have initiated incubation on an initial nest (two days) and then moved approximately 12 km and renested. Mean distances of 11 renests to the nearest booming ground was 0.9 km, (SD=.36). The nest nearest a display ground was 0.5 km, and the most distant was 1.7 km.

Causes of nest failures

Of 20 nests that were observed after destruction, 14 were attributed to mammals, and 6 to avian predators (Table 13). Red fox (*Vulpes vulpes*) appeared to be the most common cause of nest destruction. Avian predation was

surprisingly high, but in all cases except one some of the eggs were missing from the nest indicating the possibility of initial mammalian predation and secondary predation by birds.

Table 13. Suspected causes of nest destruction 1983-1984.

Cause	Number
Red fox (*Vulpes vulpes*)	8*
Avian	6*
Racoon (*Procyon lotor*)	3
Unknown mammal	2
Badger(*Taxidea taxus*)	1*
Total	20

* Includes hen that was killed while incubating.

One sharptail abandoned shortly after being flushed from the nest by a dog. The initial nest of an adult sharptail was destroyed by an avian predator and the renest by a fox.

Characteristics of Successful and Unsuccessful Nests

Of 76 prairie grouse nests, 77.6% were initiated on public land (Table 14). Most nests (59.2%) on USFS land were in 3-pasture deferred systems, but three of four booming grounds on which birds were trapped were in 3-pasture deferred systems. Success of nests was slightly higher on private land (60.0%) versus public land (51.0%), but two renests located in alfalfa may have been destroyed

by swathers if they had not been marked (Table 15). If the two nests had been destroyed, success on private land would have dropped to 46.7%. For purposes of comparison, calculations of success were based on observed nests of radio-tagged grouse. Success calculations in this section are going to differ somewhat from those made before for the following reasons: hen 1610 incubated an infertile clutch for 39 days and though biologically unsuccessful she was considered succcessful in habitat selection, and sharptails are included in this section.

Table 14. Land disturbance and ownership of land at prairie grouse nest sites, 1983-1985.

	Nest type[a]				Total		Ownership	
Land use	IN	RE	UN	PR	No.	%	Private	public
4-pasture	2	0	0	0	2	2.6	0	2
3-pasture	26	14	4	1	45	59.2	0	45
2-pasture	5	0	0	0	5	6.6	0	5
1-pasture	5	1	1	1	8	10.5	1	7
Alfalfa	4	5	0	1	10	13.2	10	0
Prairie Hay	2	0	0	1	3	3.9	3	0
Grazed	3	0	0	0	3	3.9	3	0
Total	47	20	5	4	76	99.9	17	59

[a] IN= initial nests of 43 marked prairie chickens and 4 sharptails, RE= renests of 19 marked prairie chickens and 1 sharptail, UN= nests observed unmarked prairie chickens, PR= probable nests of marked prairie chickens indicated by telemetry data.

Table 15. Success of nests related to disturbance type and ownership of land.

Disturbance	Initial No.	Initial %	Renest No.	Renest %	Total No.	Total %	Private %success	Public %success
4-pasture	2	100.0	0	-	2	100.0	-	100.0
3-pasture	26	46.2	14[a]	61.5	40[a]	51.3	-	51.3
2-pasture	5[a]	75.0	0	-	5[a]	75.0	-	75.0
1-pasture	5	20.0	1	0.0	6	16.7	0.0	20.0
Alfalfa	4	75.0	5	100.0	9	88.9	88.9	-
Prairie Hay	2	50.0	0	-	2	50.0	0.0	-
Grazed	3	0.0	0	-	3	0.0	0.0	-
Total	47[a]	47.8	20	68.4	67[a]	53.0	60.0	51.0

[a] Includes one or more nests that could not be considered successful or unsuccessful and are not included in success calculations.

Hens seldom nested on privately held grasslands and had a very low chance of success when they did. Only seven (9.2%) of all nests were found in privately held grasslands and only one of those was successful. Three of the seven nests were in portions of prairie hay fields that could not be mowed due to the roughness of terrain or moisture conditions and thus were virtually undisturbed.

Hens that incubated nests in pastures with cattle present were slightly less successful (42.9%) than hens that incubated in those without (54.1%). Only one of seven nests in a continuous system was successful. Hens avoided renesting in pastures in which cattle were present. Of 13 hens that could have selected pastures with or without cattle, when renesting, 11 selected

pastures without cattle. Both hens that renested in pastures with cattle laid their first egg four days after cattle were moved in, but localized in those pastures prior to cattle introduction. One hen renested in a 1-pasture system but initiated the nest before cattle were present. Only one renest was intiated in a pasture which had been grazed earlier in the year; this hen initiated her renest in West Carlson on 11 June, after cattle had grazed this pasture from 15 to 29 May.

There was a wide overlap in species composition of uplands and midlands and lowlands and midlands. Topography, land use and species composition were all used to determine in which community a hen nested. Most nests were in the lowland community on public land while alfalfa was utilized most often on private land (Table 16).

Table 16. Number and percent of prairie grouse nests in habitat communities 1983-1985.

	Public Land		Private Land		Total	
Habitat Community	No.	%	No.	%	No.	%
Upland	3	5.3	2	13.3	5	6.9
Midland	14	24.6	1	6.7	15	20.8
Lowland	32	56.1	3	20.0	35	48.6
Shrub	8	14.0	0	-	8	11.1
Alfalfa	0	-	9	60.0	9	12.5
Total	57	100.0	15	100.0	72[a]	100.0

[a] Does not include four nests indicated by telemetry but not observed.

Highest nest success was experienced by hens in alfalfa although as mentioned before two of those nests may have been destroyed if not marked (Table 17). Species composition was not determined at nest sites in alfalfa or at two nests in prairie where cattle introduction greatly altered the vegetation structure. In addition, one nest site was mowed before the nest analysis could be completed. Since species composition data in 1985 were gathered differently than in 1983 and 1984 they are not included in Table 18. No clear patterns were evident in species composition between successful and unsuccessful nests. One possible exception was the comparatively high nesting success when located in stands containing big and little bluestem.

Table 17. Success of radio-tagged prairie chickens and sharptails relative to community type.

Community	% successful Initial	% sucessful Renest	% successful Total
Upland	40.0	-	40.0
Midland	66.7	50.0	63.6
Lowland	34.8	60.0	43.8
Shrub	60.0	33.3	50.0
Alfalfa	75.0	100.0	88.9
Other	0.0	-	0.0
Total	47.8	68.4	53.0

Successful initial nests and renests had a higher total grass cover, total cover, and more litter than

unsuccessful nests. Unsuccessful nests had more bare ground, residual grass, and forbs (Table 19).

Table 18. Dominant species at 17 successful (S) and 19 unsuccessful (U) nests 1983-1984.

Species	Percent Cover[a]		Number[b]	
	S	U	S	U
Poa pratenses	20.90	25.54	16	17
Panicum virgatum	14.79	13.51	5	7
Andropogon gerardi	10.13	12.56	7	1
Andropogon scoparius	24.74	31.00	7	1
Calamagrostis inexpansa	18.70	8.35	3	4
Spartina pectinata	12.29	14.32	2	4
Agropyron repens	6.63	10.35	4	1
Phalaris arundinacea	0.00	8.35	0	4
Muhlenbergia asperifolia	0.00	10.40	0	5
Carex spp.	7.50	14.50	16	9
Symphoricarpus occidentalis	9.69	14.69	3	2
Spiraea alba	8.82	9.88	3	3
Solidago spp.	8.95	12.01	8	11
Anemone canadensis	8.41	13.00	2	4
Ambrosia psilostachya	8.67	9.06	3	1

a. Percent cover is a mean of those nests with greater than 5% cover.
b. Number is the number of nests used to calculate the above mean.

Grass was the most important cover provided at most of the nests (Table 19). Photo-plot analysis supported the Daubenmire data, since 73% of the obstruction categories of all nests were grass (Table 20).

Robel pole readings had lower means at successful initial nests than unsuccessful nests (Table 21). However, when all nests are combined, successful nests had

a mean overall reading of 1.01 (SD=0.40) and a mean nest site reading of 1.49 (SD=0.65) which was higher than unsuccessful nests (overall, $\overline{x}$=0.96, SD=0.46; nest site $\overline{x}$= 1.34 SD=0.58). In addition, if nests in alfalfa had been included the readings for successful nests would have been much higher.

Table 19. General vegetation characteristics at nest sites.

	Initial N=29[a]				Renests N=7[b]			
	% Cover		Frequency		% Cover		Frequency	
	S	U	S	U	S	U	S	U
Bare Ground	3.8	6.2	31.5	42.5	3.2	8.5	29.0	47.5
Litter	89.3	84.9	100.0	99.9	90.9	81.1	100.0	98.3
Residual	13.4	14.3	75.6	81.0	7.7	6.4	60.0	60.8
Total Cover	66.7	57.0	100.0	100.0	75.8	70.2	100.0	100.0
Total Forb	12.0	14.1	87.5	90.1	19.9	20.5	92.5	100.0
Total Grass	59.9	49.1	100.0	100.0	67.9	53.5	100.0	100.0

[a] n=12 successful and 17 unsuccessful.
[b] n=5 successful and 2 unsuccessful.

Table 20. Obstruction categories from photo-plot analysis at nest sites, 1983-1985.

Obstruction Category	Number	Percent of Total
Grass	5567	73.0
Forb	633	8.3
Brush	270	3.5
Grass/Forb	669	8.8
Grass/Brush	357	4.7
Grass/Forb/Brush	121	1.6
Forb/Brush	2	0.0
Miscellaneous	7	0.1

Table 21. Mean Robel pole readings at successful and unsuccessful nests, 1983-1984.

	Initial Nest		Renest	
	Overall	At Nest	Overall	At Nest
Successful	.86 SD.30	1.14 SD.29	1.39 SD.38	2.33 SD .47
Unsuccessful	.94 SD.48	1.38 SD.61	1.09 SD.36	1.79 SD1.07

Photo-plots were taken at nest sites shortly after incubation began and more accurately reflect the density and height of vegetation at the time of nest site selection. Successful initial nests and renests had a higher effective height and height of vegetation than unsuccessful nests at 0.5 and 10 m from the nest, except mean height was higher 5 m from the nest in initial unsuccessful nests (Table 22). Renests had greater effective heights and heights than initial nests and had a higher success rate. When all nests are combined, effective heights at successful nests exceeded those at unsuccessful nests by an average of 3.65, 3.29 and 3.41 cm at 0, 5 and 10 m from the nest site respectively. The average height difference between successful and unsuccessful nests was 1.84, 1.74 and 2.15 cm at 0, 5 and 10 m respectively. Also apparent from photo-plots was a decline in effective height and height at 5 m and again at 10 m from the nest.

Table 22. Mean effective height (EHT) and height (HT) of vegetation at the nest, and 5 and 10 m from the nest, 1983-1985.

Nest		NO.	0 meters		5 meters		10 meters	
			EHT	HT	EHT	HT	EHT	HT
Initial	S[a]	16	13.1 SD 3.4	35.0 SD 12.1	9.7 SD 5.1	25.5 SD 12.9	8.9 SD 5.1	25.1 SD 14.2
Initial	U[b]	18	12.5 SD 4.7	34.4 SD 11.7	9.5 SD 7.9	26.7 SD 13.8	7.9 SD 3.5	24.7 SD 12.1
Renest	S	11	25.3 SD 9.1	41.8 SD 9.8	21.1 SD 13.8	36.2 SD 15.6	19.3 SD 13.8	34.7 SD 15.9
Renest	U	6	20.8 SD 7.7	41.2 SD 7.4	15.5 SD 10.0	32.2 SD 14.8	15.1 SD 11.3	33.2 SD 14.2
Combined	S	27	18.2 SD 8.8	37.8 SD 11.6	14.4 SD 11.2	29.9 SD 15.0	13.2 SD 10.9	29.2 SD 15.6
Combined	U	24	14.5 SD 6.5	36.0 SD 11.8	11.1 SD 7.8	28.2 SD 14.2	9.8 SD 7.3	26.9 SD 13.2

[a] Successful nests
[b] Unsuccessful nests

Successful nests had greater densities of vegetation at 0, 5 and 10 m from the nest than unsuccessful nests (Table 23). Thirty-four photo-plots of successful nests had an effective height greater than or equal to 15 cm compared to only 17 photo-plots of unsuccessful nests.

Table 23. Cummulative mean effective height at 0, 5 and 10m from the nests for 50 nests, 1983-1985.

EHT (cm)	Successful N=26			Unsuccessful N=24		
	0m	5m	10m	0m	5m	10m
>=20	8	5	5	4	2	2
>=15	16	10	8	10	4	3
>=10	24	15	13	18	12	7
>=5	26	26	25	24	22	22

The first set of photo-plots were taken prior to green-up and represent the conditions available to hens initiating a nest. The second set was taken in mid-May and represents vegetation structure at the beginning of incubation just before cattle were placed in the pasture (Table 24). To permit comparison with data from the transects, a mean effective height and height was determined from all 10 photo-plots at each nest (Table 24). Comparing these two sets of data, measurements on the uplands and prairie hay transects indicate vegetative structure unattractive to nesting hens. All upland transects had effective heights of <5 cm; no initial nests

Table 24. Distribution of effective heights and heights in communities and at initial nest sites, 1983-1985.

	Early May EHT[a], HT[b]					Initial nests		Mid-May EHT, HT				
(cm)	Up[c]	Md[d]	Ll[e]	Ph[f]	Bu[g]	S[h]	U[i]	Up	Md	Ll	Ph	Bu
0-5	11,4	7,1	3,0	1,0	0,0	0,0	0,0	12,1	5,0	3,0	1,0	1,1
5-10	0,2	7,0	3,3	0,1	0,0	10,0	12,0	0,4	9,1	6,1	0,1	0,0
10-15	0,4	2,5	1,3	0,0	1,0	3,0	5,0	0,6	3,4	2,3	0,0	0,0
15-20	0,1	0,2	0,0	0,0	0,0	3,5	1,6	0,1	0,3	1,3	0,0	0,0
20-25	0,0	0,2	0,0	0,0	0,0	0,4	0,1	0,0	0,2	0,0	0,0	0,0
>25	0,0	0,6	0,3	0,0	0,1	0,7	0,11	0,0	0,7	0,3	0,0	0,0

[a] Effective height
[b] Height
[c] Upland
[d] Midland
[e] Lowland
[f] Prairie hay
[g] Burn
[h] Successful
[i] Unsuccessful

were found in that category. Primarily midlands and lowlands communities were the areas potentially providing an adequate vegetative structure within which hens could nest; however, many provided inadequate cover due to grazing and mowing.

As spring and summer progressed the photo-plot transects showed an increase in effective height and height. Structure of vegetation became more dense and taller in all three communities especially in pastures without cattle (Table 25). Table 25 excludes a Lowland II in a continuous pasture that had low numbers of cattle and a large expanse of lowlands. This pasture showed a substantial increase in vegetation during this time period even though grazed. Renests were initiated between 16 May and 23 June, although most were in early to mid-June. As indicated before, hens which renested avoided pastures with cattle and pastures which had been previously grazed. Eleven of 17 renests were in vegetation which had effective heights greater than 15 cm (Table 26). In early June only the lowlands had effective heights equal to or greater than 15 cm and only the midlands and lowlands had effective heights greater than 15 cm (Table 26).

Table 25. Increase in effective height of vegetation relative to grazing from early May to mid-June.

Community	Grazed (cm)	Ungrazed (cm)
Upland	1.65 SD .53 n=4	5.90 SD 1.52 n=4
Midland	3.38 SD 3.06 n=4	7.25 SD 3.34 n=4
Lowland	2.40 SD 1.47 n=3	10.95 SD 6.4 n=4

Brood Rearing

Brood mortality

Data for analysis of habitat use, movements and mortality of broods were collected in 1983 and 1984. Known hatching dates for initial nests ranged from 7 June to 21 June and for renests, 28 June to 19 July.

Twenty-two radio-tagged prairie chickens produced 265 chicks, all but 4 of which left the nests. Mortality of broods was high especially during the first 2.5 weeks of brood rearing. Hens 1414, 1540, and 1576 made 3.2, 11.1 and 9.7 km moves 1, 5 and 10 days respectively after successfully bringing off a brood. Periodic marking of their roosts, and flushing, indicated they had lost their entire broods prior to these moves. Five hens were killed during the brood rearing period, three within 17 days after hatching and two after 45 and 53 days.

Table 26. Distribution of effective heights and heights in communities and at renests, 1983-1985.

	Early June EHT[a], HT[b]					Renests EHT, HT		Mid-June EHT, HT				
(cm)	Up[c]	Md[d]	Ll[e]	Ph[f]	Bu[g]	S[h]	U[i]	Up	Md	Ll	Ph	Bu
0-5	4,0	3,0	0,0	-	1,0	0,0	0,0	6,1	2,0	0,0	0,0	-
5-10	2,1	9,1	6,0	-	0,1	1,0	1,0	5,1	4,1	3,0	0,0	-
10-15	0,3	4,3	1,0	-	0,0	3,0	1,0	0,3	4,1	2,1	1,0	-
15-20	0,2	0,2	2,4	-	0,0	2,0	2,0	0,3	5,2	2,1	0,0	-
20-25	0,0	0,3	0,2	-	0,0	2,1	2,1	0,2	0,3	2,1	0,1	-
>25	0,0	0,7	0,3	-	0,0	3,10	0,5	0,1	0,8	2,8	0,0	-

[a] Effective height
[b] Height
[c] Upland
[d] Midland
[e] Lowland
[f] Prairie hay
[g] Burn
[h] Successful
[i] Unsuccessful

Determining early partial brood mortality was difficult since chicks less than three weeks of age often did not flush with hens. In one instance a 24-day old chick was stepped on after two hunting dogs had searched the area and flushed only the hen. Shortly thereafter, three more chicks flushed.

To compare early and late brood mortality, the summer was divided into two time periods, from hatching until first flush and from first flush until the end of the summer. It assummed that if a hen was killed the chicks were also. Brood hens were flushed an average of 24 (SD 13.13) days after leaving the nest. Mean rate of chick loss during this early period was .31 chicks per day per hen resulting in a loss of 62.8% of the chicks. The average number of days to the end of the summer was 32.88 (SD 12.48) days, the rate of chick loss was .04 chicks per day per hen and 8.9% of all chicks were lost in this time period. Even though a wide variation existed between hens in the number of days between hatching and first flush, the rate of chick loss in the first 24 days was probably higher.

Out of 261 chicks that left the nest, only 28.4% (74) survived to the end of the summer. Average brood size for 13 hens that had chicks at the end of the summer was 5.7 (SD=3.75). To put this in perspective 45 prairie chicken hens produced a total of 74 chicks in two years. Two

radio-tagged sharptails did not produce any young in the second year of the study.

Habitat Utilization

Difficulty sometimes occurred in assigning a relocation to a specific community because of accuracy of telemetry equipment and close proximity of community types on public land. In cases where a relocation was within 41 m of another community type, those relocations were assigned an edge code. There were 1675 locations of 33 non-incubating hens from May to August. Community type locations were recorded for 921, 371, and 351 hen relocations during the renesting, brood rearing and non-brooding periods, respectively. All hen relocations in May were combined and treated as locations of renesting hens because such a high percentage of hens renested.

Use of agricultural communities. Most of the use associated with agricultural communities was in alfalfa and planted prairie hay (Table 27). Renesting hens in May spent a greater portion of time in non-native communities than any other group (Fig. 7), probably for the following reasons: cash crops such as corn had not been replanted so continued to provide a food source; alfalfa and prairie hay was growing rapidly and provided an excellent food source and cover; and 25.5% of all renests were in alfalfa.

Brood hens frequented non-native communities more during the months of June, July and August than did renesting or non-brood hens. Of all the locations recorded for broods in agricultural communities, 76.7% were in planted prairie hay, alfalfa or their associated edge communities. There was a decrease in utilization of agricultural types by broods and non-broods in August due mainly to mowing of prairie hay. Three broods used alfalfa almost exclusively during the two years of the study. When the alfalfa was mowed brood hens remained in the fields but used the edge of windbreaks and ditches for cover. Only 93 (5.7%) of all locations taken from May through August were recorded in cash crops or their associated edge (Fig. 7).

Use of native communities. All three classes of hens preferred native stands of vegetation over agricultural community types (Fig. 7). Renesting, brood and non-brood hens were relocated in native vegetation (public and private land) 57.0, 70.1 and 83.3% of the time respectively. Structurally, midland and lowland vegetation were more similar to each other than either to upland. Upland vegetation was preferred by cattle and grazed heavily throughout the summer. Very few relocations in the upland community were recorded for renesting hens in May and June (Fig. 8). Both brood and non-brood hens had more locations in lowlands during the

Table 27. Number and percent of relocations in planted communities for renesting, brood and non-brood hens from May-August, 1983-1984.

Community[a] Type	Renesting Hens No.	%[b]	%[c]	Brood Hens No.	%	%	Non-brood Hens No.	%	%	Total No.	%	%
AL	63	43.2	17.9	93	41.0	10.1	13	22.8	3.5	169	39.3	10.3
AL edge	10	6.8	2.8	17	7.5	1.8	1	1.8	.3	28	6.5	1.7
PH	38	26.0	10.8	86	37.9	9.3	12	21.1	3.2	136	31.6	8.3
PH edge	1	.7	.3	2	.9	.2	1	1.8	.3	4	.9	.2
CR	27	18.5	7.7	28	12.3	3.0	30	52.6	8.1	85	19.8	5.2
CR edge	7	4.8	.2	1	.4	.1	0	0.0	0.0	8	1.9	.5
Total	146	100.0	41.6	227	100.0	24.6	57	100.0	15.4	430	100.0	26.2

a AL=Alfalfa, PH= Planted prairie hay, CR= Crops.
b Percent of locations in planted communities.
c Percent of all relocations for that group of hens.

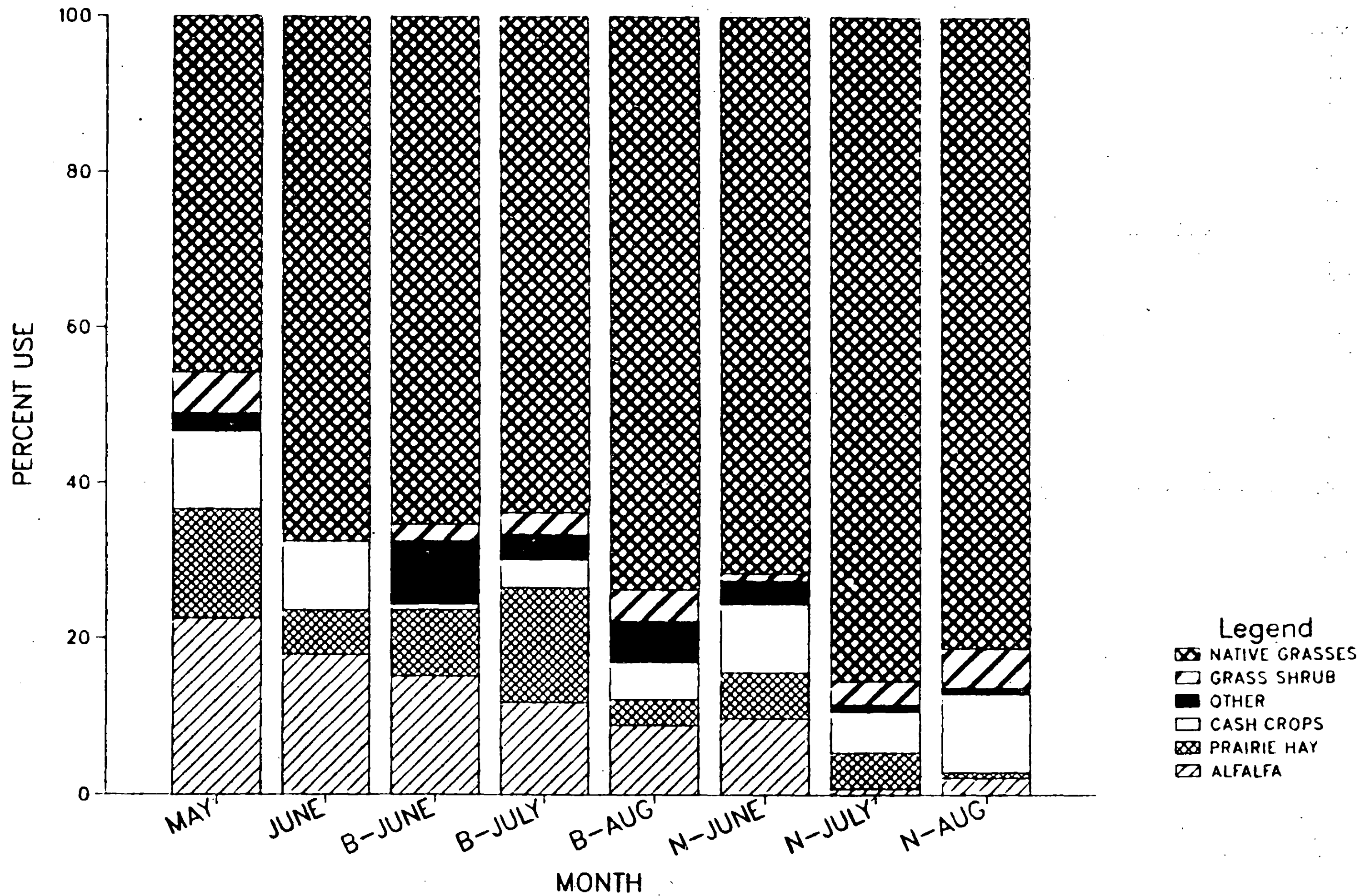

Fig. 7. Habitat use by prairie chicken hens, May through August, Sheyenne National Grasslands, 1983-1984 (Renesting hens May and June; hens with broods (B) and without broods (N), June through August).

month of June than any other month (Table 28). As the summer progressed there appeared to be differences in habitat utilization by brood and non-brood hens. In July and August non-brood hens made extensive use of upland communities and their associated edge, while broods remained relatively constant in their use of lowlands. The reason for this apparent difference in habitat use is probably related to disturbance factors and the greater height and density of vegetation in the lowland.

Table 28. Percent use of native communities, combined with their respective edges, by broods and non-broods.

	June		July		August	
	brood	non-brood	brood	non-brood	brood	non-brood
Upland	22.5	31.1	26.0	57.8	20.5	48.8
Midland	25.8	27.1	25.5	24.2	29.5	25.2
Lowland	48.3	40.6	44.1	14.6	44.8	20.1
Grass/shrub	3.3	1.4	4.3	3.4	5.2	5.9

Night Roost sites. A mean Robel pole reading of 1.03 (SD .93) was calculated from measurements taken at sixty-one roosts of grouse. Most marked roosts were in Class III or taller vegetation. It appeared that lowlands were used more frequently for roosting by broods (51.2%, N=43) than non-brood hens (33.3%, N=18). There were 165 night relocations taken, during May through August and hens used native communities in about the same proportion at night (75.2%) or day (70.3%).

Disturbance type use

Practically all of the land associated with the SNG is disturbed every year by mowing, grazing or cultivation. Selection of areas by hens seemed to be based first on land use (disturbance type) and second on community types. Past and present land uses combined provided for a unique combination of vegetative structure in any given area. Disturbance type codes were assigned to each relocation based on ownership, cattle presence, pasture type or private land use. As with habitat codes those locations of hens within 41 m of a second disturbance type were originally assigned a code for edge. However, there were relatively few edge relocations so edge codes were not incorporated in this analysis. For reasons discussed previously renesting hens were excluded from analysis. There will be slight differences between raw data totals presented here and data presented in the community use section for the following reasons. First, if a native community type was recognized within prairie hay it was assigned that community type while the disturbance code would assign it to prairie hay. Secondly, nine sorghum locations were assigned to crops in the habitat section but were treated as prairie hay in this section. Thirdly, often a relocation was assigned to a disturbance type even if it could not be assigned to a community type.

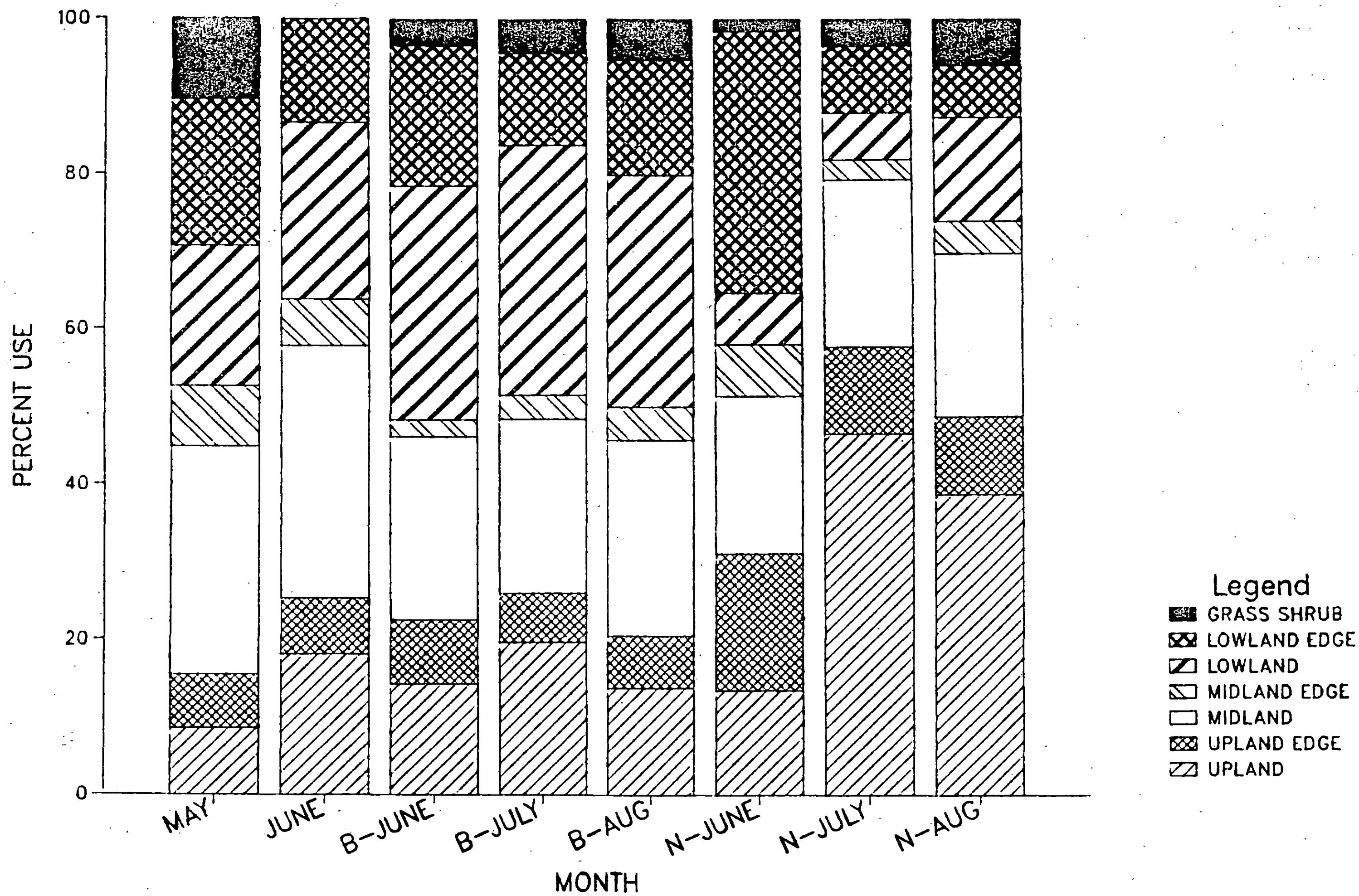

Fig. 8. Use of native habitats by prairie chicken hens, May through August, Sheyenne National Grasslands, 1983-1984. (Renesting hens May and June; hens with broods (B) and without broods (N), June through August).

Less brood hen relocations were on public land (55.6%) than non-brood hen relocations (82.7%) yet only in the month of July did either hen class spend more time on private land than public land (Table 29). Brood hens used areas that had been mowed the previous year, but were currently undisturbed more often than non-brood hens. During the month of July, 45.9% of all relocations of brood hens were in either prairie hay or alfalfa while only 8.1% of non-brood hen relocations were in those types. Alfalfa and prairie hay use by broods declined by 21.1% in August due to the mowing of those disturbance types. Hens which used prairie hay fields always left those fields after they were mowed whereas broods in alfalfa sometimes remained in those fields even after mowing occurred.

<u>Use of pastures</u>. In general 3-pasture deferred systems in areas of brood use were managed as follows. In mid-May, cattle were released into the pasture that was deferred the previous year. They were then moved between two of the three pastures on a monthly basis until mid-August or early September at which time they were moved into the deferred pasture. Lessees were encouraged to mow lowlands in the deferred pasture before 1 August. Often the lessee was able to obtain additional permits to mow lowland vegetation in other pastures within the allotment.

Table 29. Number and percent of relocations in disturbance types for brood and nonbrood hens June-August, 1983-1984.

Disturbance type	June				July				August				Total			
	Brood		Non-brood		Brood		Non-brood		Brood		Non-brood		Brood		Non-brood	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Public																
4-pasture	11	4.1	0	0.0	5	1.3	7	5.1	3	1.1	16	10.6	19	2.1	23	5.9
3-pasture	95	35.2	56	54.9	130	33.9	101	74.3	119	44.1	94	62.3	344	37.3	251	64.5
2-pasture	11	4.1	16	15.7	30	7.8	12	8.8	7	2.6	9	6.0	48	5.2	37	9.5
1-pasture	58	21.5	2	2.0	25	6.5	0	0.0	35	13.0	4	2.6	118	12.8	6	1.5
Private																
Prairie hay	41	15.2	6	5.9	131	34.2	10	7.4	43	15.9	12	7.9	215	23.3	28	7.2
Alfalfa	41	15.2	10	9.8	45	11.7	1	.7	24	8.9	3	2.0	110	11.9	14	3.6
Crops	3	1.1	9	8.8	10	2.6	5	3.7	13	4.8	11	7.3	26	2.8	25	6.4
Misc.[a]	10	3.7	3	2.9	7	1.8	0	0.0	26	9.6	2	1.3	43	4.7	5	1.3
Total	270	100.1	102	100.0	383	99.8	136	100.0	270	100.0	151	100.0	923	100.1	389	100.0

[a] Includes road ditches and undisturbed areas.

In two pasture systems, cattle were placed in one of the pastures for approximately one month and then moved to the second pasture for approximately two months. The lessee was then allowed to mow lowlands in the first pasture before cattle were moved back in. Continuous pastures had cattle in them from the start of the season until the end, with mowing occurring in some of the lowlands during July.

In June, July and August 64.8, 49.6 and 60.7% of all brood locations and 72.5, 88.2 and 81.5% of all non-brood relocations respectively were in pasture systems. Of all pasture systems utilized, 3-pasture deferred systems were used the most by both brood and non-brood hens (Table 29). Hens tended to avoid pastures with cattle and pastures that had been disturbed (grazed) earlier the present year. Of all brood and non-brood locations, 74.2% and 74.4% respectively were in areas without cattle. The deferred pasture of 3-pasture systems was used by brood and non-brood hens a high percentage of the time relative to other pastures (Table 30).

Present or prior cattle use in the same year seemed to be one of the most important factors determining the amount of brood and non-brood use, with both classes of hens seeking areas that had not been disturbed during the current year.

Table 30. Number and percent of locations in pasture systems relative to year deferred, June-Aug.

	Deferred		Deferred 1 year prior		Deferred 2 years prior		Other[a]	
	No	%	No.	%	No.	%	No.	%
Broods	179	33.8	102	19.3	51	9.6	197	37.2
Non-broods	166	52.4	20	6.3	46	14.5	85	26.8
Total	345	40.8	122	14.4	97	11.5	282	33.3

[a] includes locations in 2-pasture, 1-pasture, other 3-pasture systems without a deferred pasture and 4-pasture systems.

Vegetative structure related to disturbance type. Of the total relocations of brood and non-brood hens, 42.7 and 49.9% respectively were in deferred pastures and prairie hay. Besides these areas very few other disturbance types on the SNG go undisturbed for portions of a given summer. Prairie hay and deferred pastures represent a relatively small area compared to all the disturbance types available to a hen. The vegetative structure associated with communities in these types was the most probable reason hens made this selection.

Effective heights (EHT) and height (HT) measured along transects showed that by 15 June EHT and HT in deferred pastures was superior to EHT and HT in grazed pastures. From 15 June to 30 July EHT and HT in deferred pastures was greater in all communities except the upland

on 1 July (Figs. 9-14). One prairie hay transect in 1984 showed a trend similar to vegetation development in deferred pastures. By 15 June EHT and HT were 12.4 (SD 2.87) and 22.7 (SD 4.49) cm respectively. EHT and HT increased in prairie hay through 15 July dropped slightly 30 July and then was mowed.

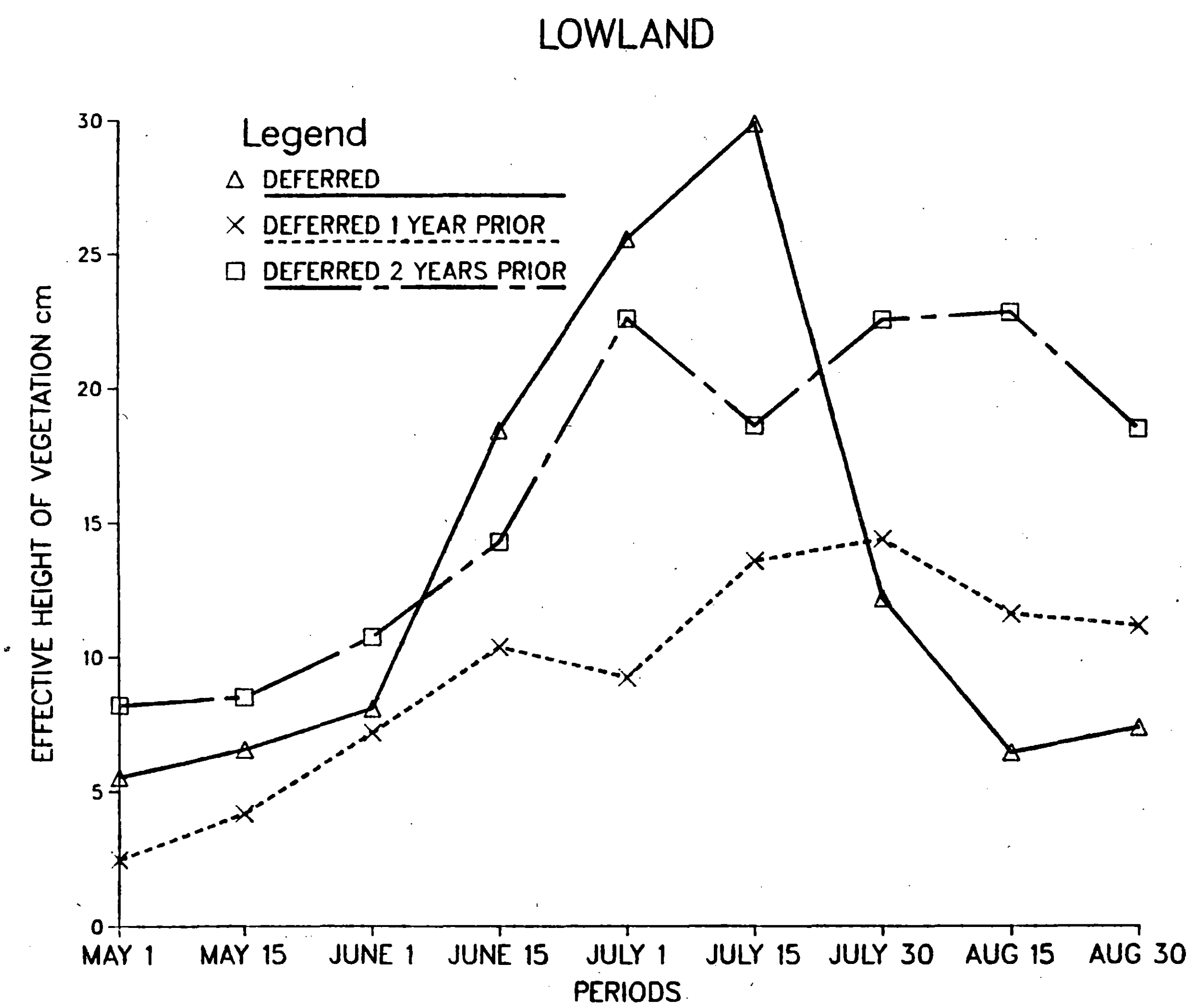

Fig. 9. Seasonal trends of effective height of vegetation on lowland transects in deferred pastures, 1983-84.

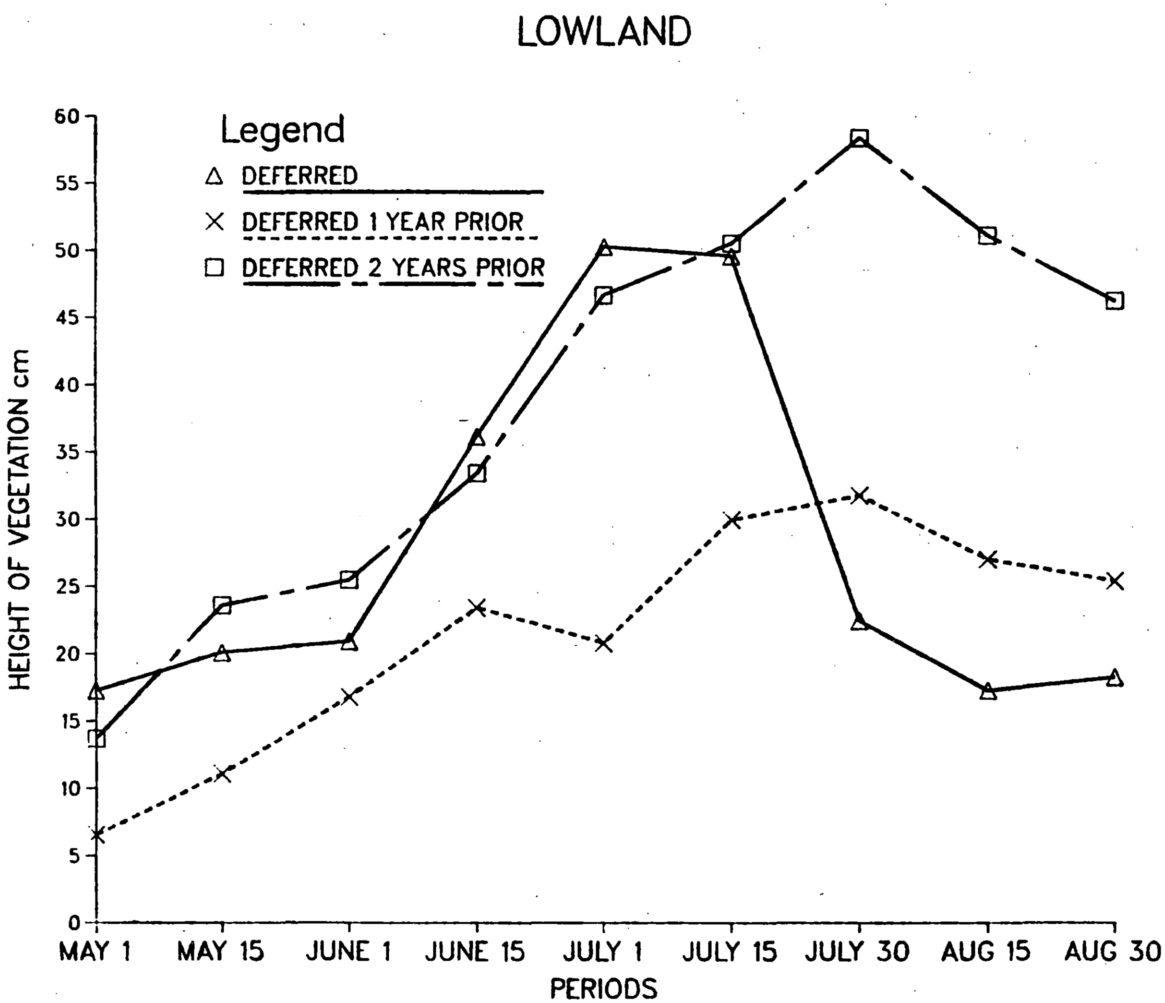

Fig. 10. Seasonal trends of height of vegetation on lowland transects in deferred pastures, 1983-84.

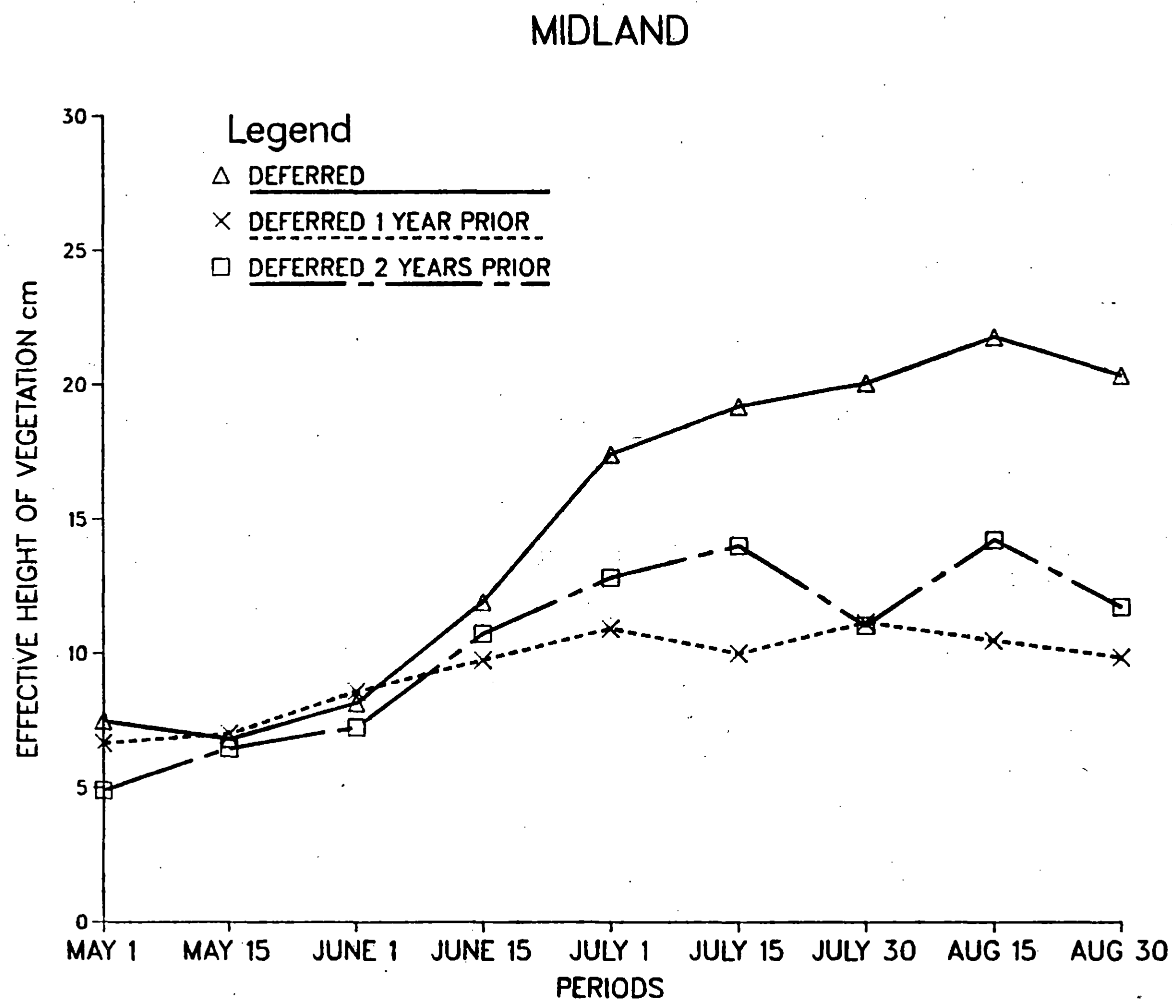

Fig. 11. Seasonal trends of effective heights of vegetation on midland transects in deferred pastures, 1983-84.

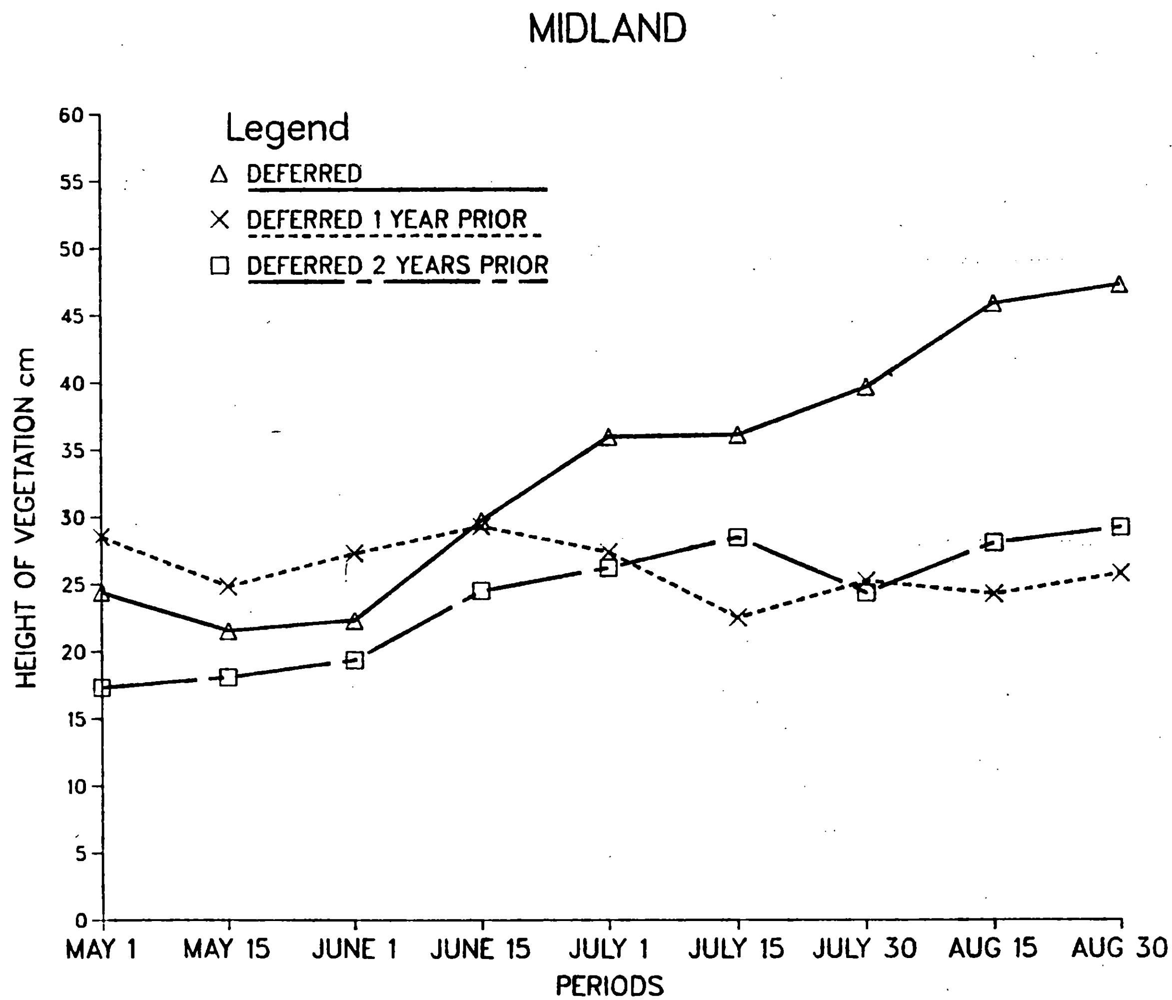

Fig. 12. Seasonal trends of height of vegetation on midland transects in deferred pasture, 1983-84.

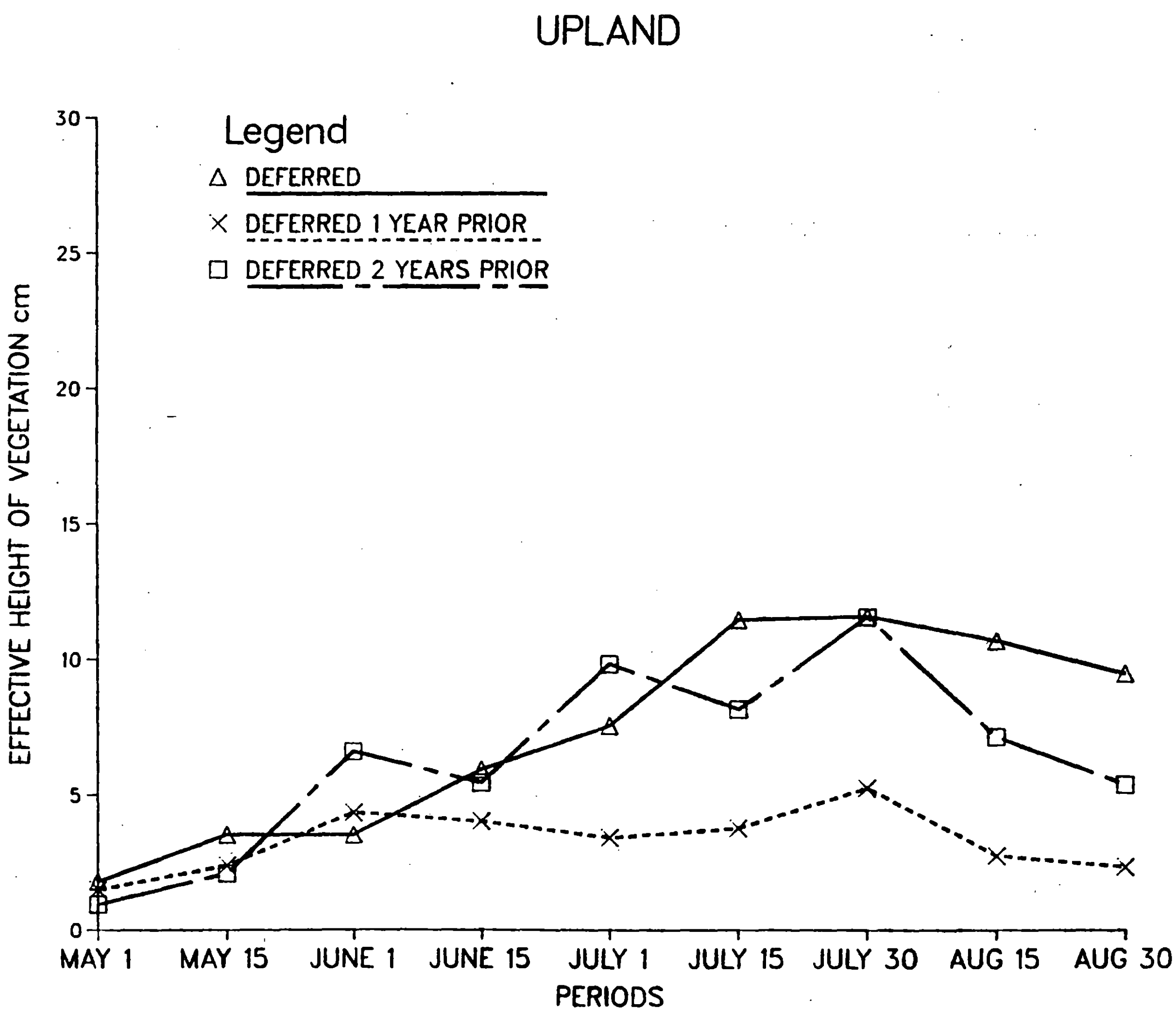

Fig. 13. Seasonal trends of effective height of vegetation on upland transects in deferred pastures, 1983-84.

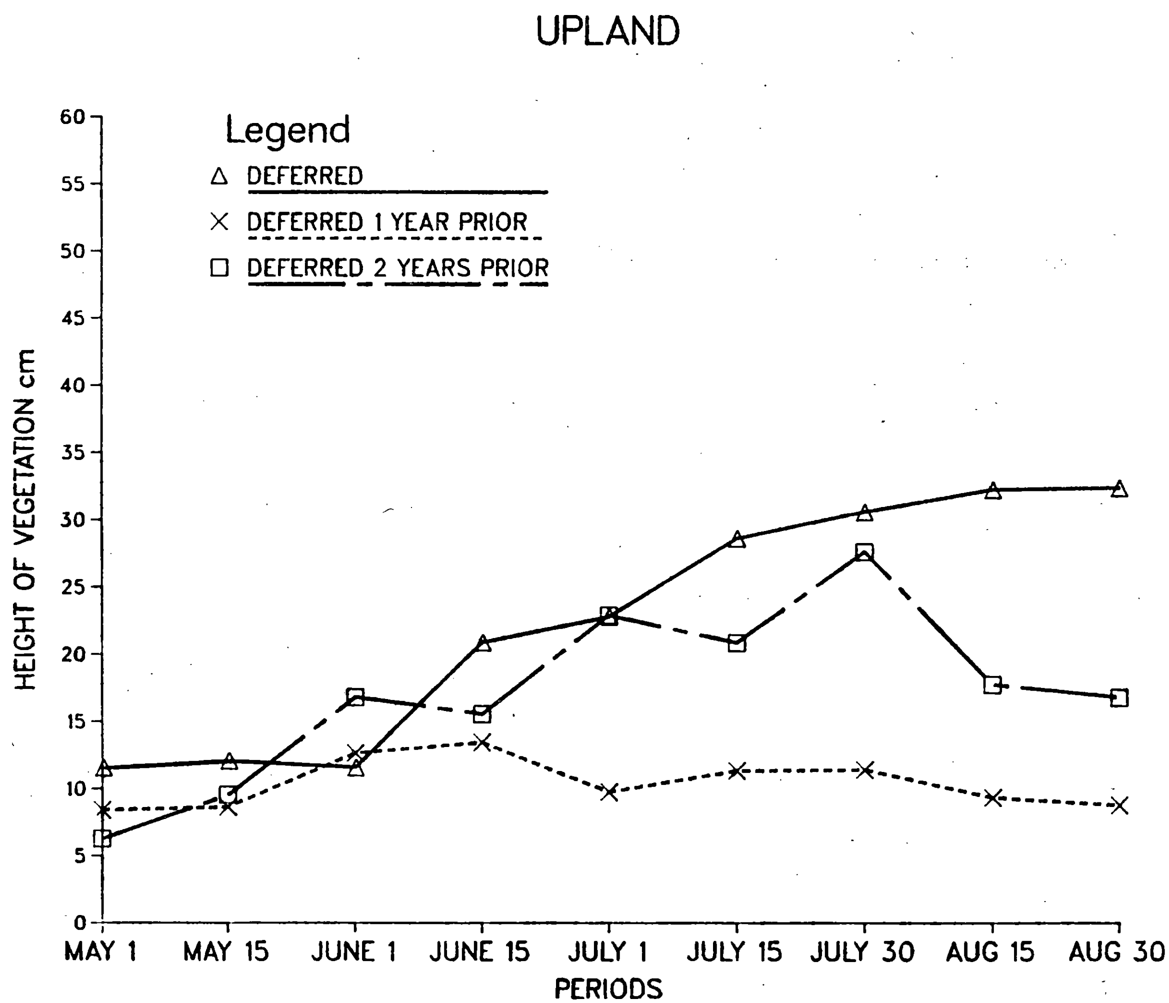

Fig. 14. Seasonal trends of height of vegetation on upland transects in deferred pastures, 1983-84.

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Appendix 1. Counts and species composition of individual display grounds on the Sheyenne National Grasslands, 1983-1985.

Display ground	1983			1984			1985		
	PC	ST	HY	PC	ST	HY	PC	ST	HY
01	37	1	0	36	0	0	40	0	0
02	35	2	4	18	1	2	10	0	0
02S	0	0	0	1	0	0	0	0	0
02E	0	0	0	1	0	0	0	0	0
03	1	0	0	0	0	0	0	0	0
03S	0	0	0	0	0	0	2	0	0
04	0	0	0	0	0	0	2	0	0
04S	0	9	0	0	11	0	0	10	0
04N	0	0	0	6	0	0	0	0	0
04W	0	0	0	4	0	0	0	0	0
05	14	5	0	11	7	0	8	0	0
06	13	0	1	28	1	0	19	0	0
07	0	0	0	0	8	0	0	7	0
08	22	0	0	7	0	0	14	0	0
09	5	2	1	5	5	0	6	0	0
10	0	4	0	0	0	0	0	2	0
10S	0	0	0	0	0	0	0	3	0
10N	0	0	0	0	0	0	0	14	0
11	1	7	0	0	8	0	0	0	0
12	5	0	0	0	8	0	0	0	0
13E	0	0	0	4	0	0	5	0	0
13W	7	12	0	0	14	0	0	13	0
14	0	0	0	0	0	0	0	3	0
15	0	1	0	0	0	0	0	0	0
16	17	1	0	13	0	0	8	0	0
17	0	0	0	0	0	0	0	8	0
18	0	0	0	0	0	0	0	6	0
19	18	0	0	19	0	0	16	0	0
20	0	0	0	0	0	0	0	9	0
21	6	1	0	12	0	0	13	0	0
23	4	0	0	6	0	0	12	0	0
24	15	0	1	13	0	1	8	2	0
24S	0	0	0	3	0	0	0	0	0
24E	0	0	0	0	0	0	1	0	0
25	25	0	0	15	1	1	16	0	1
25E	0	0	0	6	0	0	5	0	0

Appendix 1. (Continued).

Display ground	1983			1984			1985		
	PC	ST	HY	PC	ST	HY	PC	ST	HY
27	18	0	0	9	4	0	9	6	1
28	2	1	0	2	7	0	0	10	0
28W	0	0	0	0	0	0	10	0	0
29	1	7	0	0	0	0	0	6	0
30	5	9	0	0	0	0	0	8	0
31	0	0	0	0	0	0	0	5	0
32	0	0	0	0	0	0	0	4	0
33	0	11	0	0	0	0	0	7	0
34	3	1	0	9	5	0	0	0	0
34E	13	0	0	0	0	0	5	0	0
35	8	0	0	5	0	0	0	0	0
36	2	0	0	0	0	0	0	0	0
37	20	0	0	12	0	0	2	0	0
37W	0	0	0	0	0	0	1	4	0
37N	0	0	0	0	0	0	1	0	0
39	16	0	0	14	0	0	8	0	0
40	16	0	0	24	0	0	9	0	0
41	0	6	0	0	0	0	0	5	0
42	13	0	0	8	0	0	0	6	0
43	15	1	0	8	0	0	9	0	0
43S	0	0	0	0	0	0	4	0	0
44	0	0	0	0	0	0	0	2	0
45	2	12	1	0	0	0	0	0	0
46	0	0	0	0	0	0	0	9	0
48	7	0	0	8	0	0	5	0	0
49	1	0	0	0	0	0	2	0	0
51	11	0	0	4	1	0	8	0	0
52	10	0	0	2	0	0	4	0	0
53	3	0	0	0	0	0	0	0	0
UNK	0	0	0	0	11	0	0	0	0
TOTAL	391	93	8	313	92	4	262	149	2

Appendix 1. (Continued).

Display ground	1983			1984			1985		
	PC	ST	HY	PC	ST	HY	PC	ST	HY
27	18	0	0	9	4	0	9	6	1
28	2	1	0	2	7	0	0	10	0
28W	0	0	0	0	0	0	10	0	0
29	1	7	0	0	0	0	0	6	0
30	5	9	0	0	0	0	0	8	0
31	0	0	0	0	0	0	0	5	0
32	0	0	0	0	0	0	0	4	0
33	0	11	0	0	0	0	0	7	0
34	3	1	0	9	5	0	0	0	0
34E	13	0	0	0	0	0	5	0	0
35	8	0	0	5	0	0	0	0	0
36	2	0	0	0	0	0	0	0	0
37	20	0	0	12	0	0	2	0	0
37W	0	0	0	0	0	0	1	4	0
37N	0	0	0	0	0	0	1	0	0
39	16	0	0	14	0	0	8	0	0
40	16	0	0	24	0	0	9	0	0
41	0	6	0	0	0	0	0	5	0
42	13	0	0	8	0	0	0	6	0
43	15	1	0	8	0	0	9	0	0
43S	0	0	0	0	0	0	4	0	0
44	0	0	0	0	0	0	0	2	0
45	2	12	1	0	0	0	0	0	0
46	0	0	0	0	0	0	0	9	0
48	7	0	0	8	0	0	5	0	0
49	1	0	0	0	0	0	2	0	0
51	11	0	0	4	1	0	8	0	0
52	10	0	0	2	0	0	4	0	0
53	3	0	0	0	0	0	0	0	0
UNK	0	0	0	0	11	0	0	0	0
TOTAL	391	93	8	313	92	4	262	149	2